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Long-term effectiveness of physical activity promotion among insufficiently active older adults

A Self-Determination and Self-Categorization perspective

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ENGLISH SUMMARY

Regular physical activity has been recognized as a major contributor to individuals' health and well-being. Moreover, physical activity engagement has been shown to be crucial for healthy ageing and for improving (older) adults' ability to perform daily activities. Nevertheless, only half of the Western population attains the recommended physical activity level for health, with decreasing participation rates with advanced age. Considering the continuously growing proportion of older adults as well as the economic burden associated with physical inactivity, physical activity promotion has emerged as one of the public health priorities, particularly among the older adult population.

Various physical activity promoting strategies have been found to positively impact on individuals' physical activity behavior. However, those grounded in a theoretical framework have been shown to be most effective, particularly in the long term. Therefore, the main purpose of this thesis was to examine the extent to which the Self-Determination Theory and the Self-Categorization Theory contribute to the adoption and the (year-round) maintenance of physical activity behavior among (older) adults who do not attain the physical activity recommendations for health. More specifically, we studied whether, in accordance with the tenets of the Self-Determination Theory, creating a need-supportive environment yields autonomous forms of motivation and consequently sustained behavioral changes in different population groups, i.e. employees (**Study 1**) and older adults (**Study 2**). Individuals are autonomously motivated when they engage in an activity because the activity is personally important and meaningful and will help them to attain valued goals (i.e. identified regulation), because the activity fits their personality and overall lifestyle (i.e. integrated regulation) or for reasons of interest, enjoyment or challenge (i.e. intrinsic motivation). Autonomous motivation is self-initiated and therefore assumed to facilitate longer-term behavioral engagement than controlled motivation.

Furthermore, we evaluated whether, in accordance with the Self-Categorization Theory, integrating group processes and postulating social identity-based normative support for physical activity produce a more autonomous form of motivation, and consequently larger and longer-term increases in older adults' physical activity than individually-tailored need-supportive counseling (**Study 3**). Given that both the Self-Determination Theory and the Self-Categorization Theory involve assumptions that are related to behavior as well as to health, this doctoral thesis evaluated and compared the impact of the theoretically-grounded physical activity promoting strategies not only on individuals' behavioral persistence (i.e. over a period of one year) but also on their health perceptions.

The **first intervention study** aimed at examining the effectiveness of a four-month physical activity counseling based on the Self-Determination Theory among university employees who did not attain the physical activity recommendations for health (n = 126). Participants of the intervention condition (n = 92) received an individually-tailored need-supportive coaching from a bachelor in Kinesiology. Specifically, the coach facilitated participants' physical activity behavior by supporting their need for autonomy (e.g., by exploring physical activity options rather than prescribing physical activities), their need for competence

(e.g., by drafting a structured and appropriate physical activity plan or by providing positive feedback) and their need for interpersonal relatedness (e.g., by creating a warm relationship within an empathetic environment). Participants of the waiting-list control condition (n = 34) did not receive any physical activity advice or coaching.

With respect to self-reported physical activity, results showed significantly different changes over time between the intervention and control condition. In particular, the intervention condition increased in moderate (+ 158%) and strenuous (+ 436%) physical activity from baseline to four-month follow-up and in mild (+ 81%), moderate (+ 215%) and strenuous (+ 386%) physical activity from baseline to one-year follow-up. In the control condition, no changes emerged in (the different intensities of) physical activity. Autonomous motivation and self-efficacy (i.e. the confidence one has to be physically active in adverse situations such as fatigue or bad weather conditions) significantly mediated the intervention effect on (strenuous) physical activity from baseline to four-month follow-up. Social support from significant others (e.g., friends) mediated the intervention effect from baseline to one-year follow-up.

With respect to physical well-being, results showed a significantly different change over time between the intervention and control condition. In particular, the intervention condition substantially improved in physical well-being from baseline to four-month follow-up and from baseline to one-year follow-up whereas no changes emerged in the control condition. The intervention effect on physical well-being was mediated by strenuous physical activity. With respect to psychological well-being, no significant changes were found in the intervention or control condition from baseline to four-month follow-up, but however, a significant decrease emerged in both conditions from baseline to one-year follow-up.

We concluded that an individually-tailored physical activity program based on the Self-Determination Theory can positively impact on employees' physical activity behavior and their (physical) well-being, even after a one-year follow-up period. Moreover, the results underscored the importance of high quality motivation and social support in the adoption and maintenance of physical activity behavior.

The **second intervention study** aimed at examining and comparing the effectiveness of three physical activity programs varying in counseling procedure and intensity among adults aged 60 years or older who did not attain the physical activity recommendations for health (n = 442). The first strategy (i.e. referral condition; n = 146) consisted of a 15-minute contact in which a Health Fitness Specialist referred participants to local physical activity programs. The second strategy (i.e. walking condition; n = 146) embraced a 15-minute contact in which a Health Fitness Specialist provided participants a structured program consisting of walking schemes that gradually increased in volume and intensity. The walking program was assumed to inherently support participants' need for competence. The third strategy (i.e. need-supportive coaching condition; n = 150) comprised a ten-week multiple-contact individually-tailored physical activity counseling in which a Health Fitness Specialist supported participants' needs for autonomy, competence and relatedness, consistent with the tenets of the Self-Determination Theory.

With respect to physical activity, each of the programs yielded significant and substantial increases in daily steps and self-reported physical activity from baseline to ten-week follow-up. However, significantly

larger increases emerged in the walking condition (e.g., self-reported physical activity: + 104%) and the need-supportive coaching condition (e.g., self-reported physical activity: + 116%) compared with the referral condition (e.g., self-reported physical activity: + 65%). Similarly, each of the programs yielded significant increases in self-reported physical activity from baseline to one-year follow-up, with larger increases in the walking condition (+ 131%) and the need-supportive coaching condition (+ 166%) than in the referral condition (+ 92%). With respect to daily steps from baseline to one-year follow-up, significant increases were found in the walking and the need-supportive coaching condition whereas no changes emerged in the referral condition, but however, no significant time by condition interaction effect emerged. Autonomous motivation mediated the relation between participants' perceived need-support of the coach and their physical activity level, irrespective of intervention condition.

With respect to subjective health, results showed no significantly different changes over time between the referral condition, the walking condition and the need-supportive coaching condition. However, each of the programs yielded significant improvements in subjective well-being and trait anxiety, from baseline to ten-week follow-up and from baseline to one-year follow-up. From baseline to two-year follow-up, no changes emerged in subjective well-being, indicating a relapse to baseline level two years after the intervention. Similarly, trait anxiety significantly increased from baseline to two-year follow-up. The improvements in participants' health perception were significantly predicted by their increases in physical activity. Also a higher level of perceived need-support of the coach contributed to a better subjective health.

We concluded that physical activity promoting programs varying in counseling strategy and intensity can positively affect older adults' physical activity and subjective health, even after a one-year follow-up period. However, an individualized and (partially) need-supportive physical activity program seemed to be more successful in producing long-term physical activity engagement than a referral to widespread opportunities. In this respect, and considering its one-contact character, providing a structured (walking) program appears to be a potentially effective strategy to implement at a large scale. Furthermore, the findings pointed out the key role of autonomous motivation in the transition from an inactive to regularly active lifestyle in older adults. At the same time, an increased physical activity level and satisfactory feelings of perceived need-support emerged as important determinants of older adults' subjective health over a one-year follow-up period.

The **third intervention study** aimed at examining and comparing the effectiveness of three six-week identity-based physical activity counseling strategies among adults aged 55 to 70 years who did not attain the physical activity recommendations for health (n = 169). The first strategy (personal identity condition; n = 56) consisted of an individually-tailored need-supportive physical activity coaching based on the Self-Determination Theory. A Health Fitness Specialist targeted participants' personal self, and thus their unique characteristics. Participants were encouraged to engage in physical activity for their own personally valued reasons (e.g., because of the health-related benefits, because of the social contact, in order to work off steam etc.). The second strategy (social identity condition; n = 57) embraced a socially-

oriented physical activity promoting program based on the Self-Categorization Theory. A Health Fitness Specialist targeted participants' social self and provided group-based normative support for physical activity. More specifically, physical activity behavior was proposed as prototypical for a relevant reference group within this population. Based on the results of a preliminary survey (n = 1340), 'socially engaged persons' and 'independent persons' were considered as the most appropriate reference groups to be used in the physical activity intervention. The third strategy (joined identity condition; n = 56) comprised a physical activity counseling procedure based on the Self-Determination and Self-Categorization Theory. A Health Fitness Specialist facilitated participants' physical activity behavior by targeting both their personal and social self.

With respect to physical activity, each of the strategies yielded significant and substantial increases in daily steps, daily aerobic minutes and self-reported physical activity, from baseline to six-week follow-up (e.g., steps: personal identity condition: + 75%; social identity condition: + 68%; joined identity condition: + 71%) and from baseline to one-year follow-up (e.g., steps: personal identity condition: + 62%; social identity condition: + 56%; joined identity condition: + 69%). Changes over time did not significantly differ between the interventions, except for aerobic minutes, which increased significantly more in the social identity condition from baseline to six-week follow-up than in the personal identity condition. Consistent with the tenets of the Self-Determination Theory, the relation between perceived need-support and physical activity was mediated by identified regulation (i.e. being physically active because of its valued outcomes such as health benefits). Consistent with the Self-Categorization Theory, the relation between perceived normative support and physical activity was mediated by integrated regulation (i.e. being physically active because it fits your personality and your overall lifestyle and goals).

With respect to the self-rated health, significant increases emerged in the social identity condition and the joined identity condition from baseline to six-week follow-up and from baseline to one-year follow-up whereas no changes emerged in the personal identity condition. Physical well-being significantly increased in the joined identity condition from baseline to six-week follow-up and from baseline tot one-year follow-up whereas no changes occurred in the personal identity condition and the social identity condition. Finally, psychological well-being significantly improved in the joined identity condition from baseline to six-week follow-up whereas no changes emerged in the personal identity condition and the social identity condition. Participants' self-rated health and physical well-being were positively related to their daily steps. In addition, participants' degree of identification with a relevant social identity was significantly and positively related to each of the proposed dimensions of their subjective health.

We concluded that physical activity promoting strategies targeting individuals' personal self, their social self or both their personal and social self are (equally) effective in increasing physical activity in the older adult population, even after a one-year follow-up period. However, the socially-oriented strategy that postulated group-based physical activity norms involved a non-individualized approach, and accordingly entailed relatively low costs. Therefore, a Self-Categorization Theory-based program appears to be particularly beneficial to implement in the wider community compared with individually-tailored Self-

Determination Theory-based physical activity coaching. Moreover, the findings pointed out the importance of activating a highly qualitative behavioral regulation, either identified or integrated, to perform physical activity behavior in the short and the long term. With respect to perceived health, it was concluded that emphasizing older adults' membership of a meaningful and positively valued group can positively affect their subjective health and well-being. In this respect, it seems that not only being but also perceiving oneself as a physically active person contributes to satisfactory health perceptions.

In conclusion, both the Self-Determination and Self-Categorization Theory have been demonstrated to be valuable frameworks within the domain of physical activity promotion. Specifically, various individually-tailored need-supportive strategies as well as a socially-oriented procedure that postulated normative support yielded substantial and equal increases in (older) adults' physical activity level, even after a one-year follow-up period. In this respect, the number of individuals who attained the physical activity recommendations for health increased up to 50% after participation in one of the programs. In addition to facilitating behavioral changes, each of these strategies has been shown to positively affect different dimensions of subjective health and well-being. However, it should be pointed out that both a one-contact need-supportive strategy and a group-based counseling are less time-consuming procedures than a multiple-contact personalized physical activity coaching. Therefore, these two strategies appear to be particularly beneficial to implement at a large scale, and accordingly impact on public health. Finally, both personally-oriented and socially-oriented physical activity programs should strive to facilitate highly qualitative forms of behavioral regulation, either identified, integrated or intrinsic, in order to successfully encourage individuals' to perform physical behavior in the short and the long term. Physical activity promoting strategies should thus put emphasis on the valued outcomes of physical activity, on its harmony with individuals' lifestyle or on the fun that is associated with it.

DUTCH SUMMARY - SAMENVATTING

Regelmatige fysieke activiteit is een belangrijke determinant van een goede gezondheid. Bovendien is fysiek actief gedrag essentieel om gezond ouder te worden en om dagelijkse activiteiten gemakkelijk(er) uit te voeren. Echter, slechts de helft van de Westerse bevolking behaalt de gezondheidsaanbevelingen van fysieke activiteit, en deelname aan fysieke activiteit daalt met toenemende leeftijd. Gezien de groeiende proportie van ouderen alsook de economische lasten die gepaard gaan met fysieke inactiviteit, wordt de promotie van fysieke activiteit aanzien als een van de prioriteiten binnen het algemeen gezondheidsbeleid, en in het bijzonder in de oudere populatie.

De effectiviteit van diverse strategieën ter promotie van fysieke activiteit werd reeds veelvuldig aangetoond. Echter, strategieën die gebaseerd zijn op een theoretisch kader leidden doorgaans tot de meest positieve resultaten, in het bijzonder op lange termijn. In dit opzicht was het voornaamste doel van deze doctoraatsthesis het bestuderen van de mate waarin de Zelf-Determinatietheorie en de Zelf-Categorizatietheorie bijdragen tot het aannemen en behouden (na een jaar) van fysiek actief gedrag bij (oudere) volwassenen die onvoldoende fysiek actief zijn om gezondheidsvoordelen te ervaren. Meer specifiek werd onderzocht of, in overeenstemming met de Zelf-Determinatietheorie, het creëren van een noodondersteunende omgeving tot autonome vormen van motivatie en bijgevolg tot een blijvende gedragsverandering leidt in verschillende populatiegroepen, i.e. personeelsleden van een universiteit (**Studie 1**) en ouderen (**Studie 2**). Een individu is autonoom gemotiveerd wanneer hij / zij een activiteit uitvoert die betekenisvol is en een waardevolle uitkomst heeft (i.e. geïdentificeerde regulatie), omdat de activiteit past bij zijn / haar levensstijl en bij de persoon die hij / zij is (i.e. geïntegreerde regulatie) of omwille van het plezier dat gepaard gaat met het uitvoeren van de activiteit (i.e. intrinsieke motivatie). Autonoom gemotiveerd gedrag wordt gesteld op vrijwillige basis en wordt daarom verondersteld op langere termijn volgehouden te worden dan gecontroleerd gedrag.

Verder werd bestudeerd of, in overeenstemming met de Zelf-Categorizatietheorie, het integreren van groepsprocessen en het poneren van fysieke activiteit als normatief gedrag een meer autonome vorm van motivatie en bijgevolg een grotere toename in fysieke activiteit teweegbrengen dan geïndividualiseerde noodondersteunende coaching (**Studie 3**). Gezien de Zelf-Determinatietheorie en de Zelf-Categoriezatietheorie zowel gedragsgerelateerde als gezondheidsgerelateerde veronderstellingen poneren, had deze doctoraatsthesis als doel het evalueren en vergelijken van de impact van verschillende bewegingsprogramma's op blijvende gedragsverandering (over een periode van een jaar) en op subjectief welbevinden.

De **eerste interventiestudie** had als doel de effectiviteit te bestuderen van een vier maanden durende bewegingscoaching gebaseerd op de Zelf-Determinatietheorie bij personeelsleden van de KU Leuven die onvoldoende fysiek actief waren om de gezondheidsvoordelen van fysieke activiteit te ervaren (n = 126). Deelnemers aan het bewegingsprogramma (i.e. interventiegroep; n = 92) kregen een geïndividualiseerde noodondersteunende coaching van een bachelor in de Bewegingswetenschappen.

Meer specifiek bevorderde de coach het fysiek actief gedrag van de deelnemers door ondersteuning te bieden voor hun nood aan autonomie (bijv., door samen met de deelnemer verschillende bewegingsactiviteiten te verkennen eerder dan het zelf bepalen van de uit te voeren bewegingsactiviteiten), hun nood aan competentie (bijv., door een gestructureerd bewegingsplan op te stellen in overeenstemming met de noden en de mogelijkheden van de deelnemer of door positieve feedback te geven) en hun nood aan verbondenheid (bijv., door een goede en persoonlijke band te creëren met de deelnemer). De controlegroep (n = 34) kreeg noch bewegingsadvies noch enige vorm van coaching.

De resultaten toonden aan dat zelfgerapporteerde fysieke activiteit verschillend evolueerde in de interventie- en controlegroep. Meer specifiek steeg de interventiegroep aanzienlijk in matige (+ 158%) en intense (+ 436%) fysieke activiteit onmiddellijk na de bewegingscoaching en in lichte (+ 81%), matige (+ 215%) en intense (+ 386%) fysieke activiteit een jaar na de coaching. In de controlegroep daarentegen werden geen veranderingen in (de verschillende intensiteiten van) fysieke activiteit vastgesteld. Autonome motivatie en eigen effectiviteit (i.e. het geloof dat men heeft om fysiek actief te zijn in moeilijke of ongunstige situaties zoals bij vermoeidheid of slechte weersomstandigheden) medieerden de effecten van de bewegingsinterventie op (intense) fysieke actviteit na de interventie. Sociale steun van betekenisvolle anderen (bijv., vrienden) medieerde het effect op lange termijn.

De resultaten toonden eveneens aan dat fysiek welzijn verschillend evolueerde in de interventie- en controlegroep. Meer specifiek verbeterde fysiek welzijn in de interventiegroep, zowel onmiddellijk na de bewegingscoaching als een jaar na de coaching. In de controlegroep werden geen veranderingen met betrekking tot fysiek welzijn vastgesteld. Het effect van de bewegingsinterventie op fysiek welzijn was gemedieerd door intense fysieke activiteit. Met betrekking tot psychologisch welzijn werden geen verschillen gevonden onmiddellijk na de bewegingscoaching tussen de interventie- en controlegroep. Echter, een jaar na de coaching was psychologisch welzijn gedaald in beide condities.

We concludeerden dat een geïndividualiseerd bewegingsprogramma gebaseerd op de Zelf-Determinatietheorie een positieve invloed kan hebben op het bewegingsgedrag alsook op het (fysiek) welzijn van personeelsleden van een universiteit, zelfs een jaar na deelname aan het bewegingsprogramma. De resultaten onderstreepten eveneens het belang van kwalitatief hoogstaande motivatie en van sociale steun in het aannemen en behouden van een fysiek actieve levensstijl.

De **tweede interventiestudie** had als doel de effectiviteit te bestuderen van en te vergelijken tussen drie bewegingsprogramma's die varieerden in coachingsstrategie en -intensiteit bij personen van 60 jaar of ouder die onvoldoende fysiek actief waren om de gezondheidsvoordelen van fysieke activiteit te ervaren (n = 442). De eerste strategie (i.e. doorverwijzingsconditie; n = 146) bestond uit een vijftien minuten durend contact waarin een master in de Bewegingswetenschappen de deelnemers doorverwees naar bestaande lokale bewegingsprogramma's. De tweede strategie (i.e. wandelconditie; n = 146) bestond uit een vijftien minuten durend contact waarin een master in de Bewegingswetenschappen de deelnemers een gestructureerd programma aanbood bestaande uit wandelschema's met een geleidelijk toenemend wandelvolume en -intensiteit. Er werd verondersteld dat het wandelprogramma de nood aan competentie

van de deelnemers impliciet ondersteunde. De derde strategie (i.e. noodondersteunende coachingsconditie; n = 150) bestond uit een tien weken durende geïndividualiseerde bewegingscoaching met meerdere contactmomenten. In overeenstemming met de Zelf-Determinatietheorie ondersteunde een master in de Bewegingswetenschappen de nood aan autonomie, de nood aan competentie en de nood aan verbondenheid van de deelnemers.

Elke bewegingsstrategie leidde tot een aanzienlijke toename in het dagelijkse aantal stappen en in zelfgerapporteerde fysieke activiteit na tien weken. Echter, er werd een grotere toename vastgesteld in de wandelconditie (bijv., zelfgerapporteerde fysieke activiteit: + 104%) en de noodondersteunende coachingsconditie (bijv., zelfgerapporteerde fysieke activiteit: + 116%) dan in de doorverwijzingsconditie (bijv., zelfgerapporteerde fysieke activiteit: + 65%). Elke bewegingsstrategie leidde eveneens tot een toename in zelfgerapporteerde fysieke activiteit na een jaar, eveneens met een grotere toename in de wandelconditie (+ 131%) en de noodondersteunende coachingsconditie (+ 166%) dan in de doorverwijzingsconditie (+ 92%). Met betrekking tot de evolutie in het dagelijkse aantal stappen na een jaar werd geen significant verschil gevonden tussen de drie strategieën. Nochtans toonden de resultaten een toename aan in de wandelconditie en de noodondersteunende coachingsconditie maar niet in de doorverwijzingsconditie. Autonome motivatie medieerde de relatie tussen de gepercipieerde noodondersteuning van de coach en de graad van fysieke activiteit, ongeacht de bewegingsinterventie.

Met betrekking tot de gemeten dimensies van gezondheid werden geen verschillen in evolutie vastgesteld tussen de drie bewegingsstrategieën. Elke strategie leidde tot een verbetering in subjectief welzijn en angstdispositie, zowel onmiddellijk na de bewegingsinterventie als een jaar na de interventie. Twee jaar na deelname aan het bewegingsprogramma was er een terugval in subjectief welbevinden tot het oorspronkelijke niveau en steeg de angstdispositie tot boven het oorspronkelijke niveau. De verbetering in de gezondheidsperceptie van de deelnemers was positief gerelateerd aan de stijging in fysieke activiteit. Ook een hogere graad van gepercipieerde noodondersteuning van de coach droeg bij tot een beter subjectief welbevinden.

We concludeerden dat bewegingsprogramma's die variëren in coachingsstrategie en -intensiteit het fysiek actief gedrag en het subjectief welbevinden van ouderen positief kunnen beïnvloeden, zelfs een jaar na deelname aan het bewegingsprogramma. Echter, een geïndividualiseerd en (gedeeltelijk) noodondersteunend bewegingsprogramma leek succesvoller te zijn in het teweegbrengen van fysiek actief gedrag op lange termijn dan een doorverwijzing naar wijdverspreide bewegingsmogelijkheden. Aangezien de wandelconditie slechts een eenmalig contact inhield, lijkt het aanbieden van een gestructureerd programma een groot potentieel te hebben om op grote schaal geïmplementeerd te worden. Daarnaast wezen de resultaten ook op de belangrijke rol van autonome motivatie in de overgang van een inactieve naar regelmatig actieve levensstijl bij ouderen. Tegelijkertijd zijn een verhoogde graad van fysieke activiteit en voldoende gepercipieerde noodondersteuning bepalende factoren voor het subjectief welbevinden bij ouderen over een periode van een jaar.

De **derde interventiestudie** had als doel de effectiviteit te bestuderen van en te vergelijken tussen drie zes weken durende en op identiteit gebaseerde bewegingsprogramma's bij personen tussen 55 en 70 jaar die onvoldoende fysiek actief waren om de gezondheidsvoordelen van fysieke activiteit te ervaren (n = 169). De eerste strategie (een op persoonlijke identiteit gebaseerde interventie; n = 56) bestond uit een geïndividualiseerde noodondersteunende bewegingscoaching gebaseerd op de Zelf-Determinatietheorie. Een master in de Bewegingswetenschappen benadrukte de persoonlijke identiteit van de deelnemers en dus hun unieke eigenschappen. De deelnemers werden aangemoedigd om fysiek actief te zijn omwille van persoonlijke redenen (bijv., omwille van de gezondheidsvoordelen van fysieke activiteit, omwille van het sociaal contact, om stoom af te blazen enz.). De tweede strategie (een op sociale identiteit gebaseerde interventie; n = 57) bestond uit een sociaal georiënteerd bewegingsprogramma gebaseerd op de Zelf-Categorizatietheorie. Een master in de Bewegingswetenschappen benadrukte de sociale identiteit van de deelnemers en koppelde fysieke activiteit als normatief gedrag aan deze identiteit. Meer specifiek werd fysieke activiteit als een typisch gedrag geponeerd van 'sociaal geëngageerde personen' en 'onafhankelijke personen'. De resultaten van een voorafgaande enquête (n = 1340) toonden aan dat deze twee referentiegroepen als relevant beschouwd worden binnen de oudere populatie. De derde strategie (een op gedeelde identiteit gebaseerde interventie; n = 56) bestond uit een bewegingsprogramma gebaseerd op de Zelf-Determinatie- en de Zelf-Categorizatietheorie, waarbij een master in de Bewegingswetenschappen het fysiek actieve gedrag van de deelnemers bevorderde door in te spelen op zowel hun persoonlijke als hun sociale identiteit.

Elke bewegingsstrategie leidde tot een aanzienlijke toename in het dagelijkse aantal stappen, in het dagelijkse aantal aërobe minuten en in zelfgerapporteerde fysieke activiteit, zowel onmiddellijk na het zes weken durende programma (bijv., dagelijkse aantal stappen: persoonlijke identiteitsconditie: + 75%; sociale identiteitsconditie: + 68%; gedeelde identiteitsconditie: + 71%) als een jaar na het programma (bijv., dagelijkse aantal stappen: persoonlijke identiteitsconditie: + 62%; sociale identiteitsconditie: + 56%; gedeelde identiteitsconditie: + 69%). Fysieke activiteit evolueerde niet verschillend tussen de drie bewegingsstrategieën, behalve voor aërobe minuten. Meer specifiek werd onmiddellijk na de bewegingscoaching een grotere toename in aërobe minuten waargenomen in de sociale identiteitsconditie dan in de persoonlijke identiteitsconditie. In overeenstemming met de Zelf-Determinatietheorie werd de relatie tussen gepercipieerde noodondersteuning en fysieke activiteit gemedieerd door geïdentificeerde regulatie (i.e. fysiek actief zijn omwille van betekenisvolle uitkomsten zoals gezondheidsvoordelen). In overeenstemming met de Zelf-Categorizatietheorie werd de relatie tussen gepercipieerde normen en fysieke activiteit gemedieerd door geïntegreerde regulatie (i.e. fysiek actief zijn omdat het past bij je levensstijl en bij wie je bent).

De sociale identiteitsconditie en de gedeelde identiteitsconditie leidden tot een verbetering in de gezondheidsperceptie van de deelnemers, zowel onmiddellijk na de bewegingsinterventie als een jaar na de interventie. Geen verandering in gezondheidsperceptie werd aangetoond in de persoonlijke identiteitsconditie. Voorts werd een toename in fysiek welbevinden vastgesteld in de gedeelde

identiteitsconditie, eveneens na zes weken en na een jaar, terwijl geen veranderingen in fysiek welzijn waargenomen werden in de persoonlijke identiteitsconditie en de sociale identiteitsconditie. Tot slot leidde de gedeelde identiteitsconditie tot een verbeterd psychologisch welzijn onmiddellijk na het bewegingsprogramma, terwijl de persoonlijke identiteitsconditie en de sociale identiteitsconditie geen veranderingen in psychologisch welbevinden teweegbrachten. De zelfgerapporteerde gezondheid en het fysiek welbevinden waren positief gerelateerd aan het dagelijkse aantal stappen. Daarnaast was de graad van identificatie met een relevante sociale identiteit positief gerelateerd aan elke dimensie van subjectief welbevinden.

We concludeerden dat bewegingsprogramma's die inspelen op individuen hun persoonlijke identiteit, hun sociale identiteit of beide identiteiten (even) effectief zijn in het bevorderen van fysiek actief gedrag bij ouderen, zelfs een jaar na deelname aan het programma. Echter, de sociaal georiënteerde strategie waarbij fysieke activiteit als normatief gedrag voor een groepslidmaatschap naar voren geschoven werd, veronderstelde geen geïndividualiseerde aanpak en bracht bijgevolg relatief weinig kosten met zich mee. Een bewegingsprogramma gebaseerd op de Zelf-Categorizatietheorie lijkt dus bijzonder voordelig om in de maatschappij te implementeren, zeker ten opzichte van een geïndividualiseerde bewegingscoaching gebaseerd op de Zelf-Determinatietheorie. Daarnaast wezen de resultaten op het belang van het activeren van een kwalitatief hoogstaande vorm van motivatie, hetzij geïdentificeerd of geïntegreerd, om fysiek actief gedrag te stellen op korte en op lange termijn. Met betrekking tot gezondheid concludeerden we dat het benadrukken van het lidmaatschap van een relevante en positief gewaardeerde groep het subjectief welbevinden bij ouderen positief kan beïnvloeden. In dit geval kan niet enkel het fysiek actief gedrag maar ook het zich identificeren met een fysiek actieve persoon bijdragen tot een goede gezondheidsperceptie.

Globaal concludeerden we dat de Zelf-Determinatie- en de Zelf-Categorizatietheorie waardevolle theoretische kaders zijn binnen het domein van de promotie van fysieke activiteit. Meer specifiek werd aangetoond dat zowel verschillende geïndividualiseerde en noodondersteunende strategieën als een sociaal georiënteerde procedure waarin fysieke activiteit als normatief gedrag wordt geponeerd tot aanzienlijke en even grote toenames in fysieke activiteit kunnen leiden, zelfs een jaar na deelname aan het bewegingsprogramma. In dit opzicht was het aantal deelnemers dat de gezondheidsaanbevelingen van fysieke activiteit behaalde na deelname aan een van de bewegingsinterventies aanzienlijk groter dan voor deelname aan de interventie, zelfs tot 50%. Naast het bevorderen van gedragsverandering had elk van bovenstaande strategieën een positieve impact op verschillende dimensies van subjectief welbevinden. Echter, zowel de noodondersteunende strategie met een eenmalig contact als de sociaal georiënteerde strategie zijn minder tijdrovend dan een gepersonaliseerde bewegingscoaching met meerdere contactmomenten. Bijgevolg lijken die twee eerste strategieën bijzonder voordelig om op grote schaal te implementeren en zo de fysieke activiteit en gezondheid op populatieniveau te bevorderen. Tot slot, zowel geïndividualiseerde als sociaal georiënteerde bewegingsprogramma's zouden kwalitatief hoogstaande vormen van motivatie moeten activeren, hetzij geïdentificeerd, geïntegreerd of intrinsiek, om individuen op een succesvolle wijze aan te moedigen om fysiek actief te zijn op korte en op lange termijn. Strategieën ter

promotie van fysieke activiteit zouden dus de nadruk moeten leggen op de betekenisvolle uitkomst van fysieke activiteit, op het passen van fysiek actief gedrag bij de levensstijl of op het plezier dat ermee gepaard gaat.

Part 1

General introduction and outline

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1. Societal rationale for physical activity promotion

1.1. Ageing population

The advancing knowledge of hygiene and biomedicine has resulted in an *increased life expectancy* in industrialized countries (Hayflick, 2000). In North America and Western Europe, life expectancy at birth has been increasing by eight years since 1970 and by more than 30 years over the last century (Leon, 2011; National Center for Health Statistics, 2007). Accordingly, nowadays, Western European citizens aged 65 years are expected to live an additional 15.5 years (Studiedienst Vlaamse Regering, 2012; World Health Organization, 2012). Even though women have a greater life expectancy than men, they generally spend a shorter share of their lifetime in good health (World Health Organization, 2012). The increased life expectancy in Western societies does not only yield a continuous ageing of the world's population but also a continuously growing proportion of older adults (Leon, 2011; Lutz, Sanderson, & Sherbov, 2008). Given that the speed of ageing is likely to increase over the next decades, the proportion of Western European adults aged 60 years or older is estimated to increase with 21% in 2010, with 31% in 2030 and even with 37% in 2050 (Eurostat, 2011; Federale Overheidsdienst Economie, 2011; Lutz et al., 2008). The proportion of older adults in Belgium is similar to the European average (European Social Network, 2008).

Besides the finding that people over 65 are the fastest growing population segment in industrialized nations, they carry the largest proportion of *chronic diseases* and disabilities (King, Rejeski, & Buchner, 1998; Naughton, Bennett, & Feely, 2006). Approximately 88% of them have at least one chronic health condition such as cardiovascular disease, diabetes mellitus, cancer or depression (Hoffman, Rice, & Sung, 1996). Moreover, a large number of older adults suffer from low functional capacity and muscle weakness which may contribute to a loss of independence, impaired functioning and a reduced quality of life (Crews & Zavotka, 2006; Doherty, 2003; King et al., 1998).

1.2. Technological advancements

Not only advanced age is associated with a higher risk of chronic diseases, also *physical inactivity* has been recognized as a (modifiable) risk factor for a variety of chronic health conditions, and even as an independent predictor of mortality (Blair, 2009; Blair & Brodney, 1999; Warburton, Nicol, & Bredin, 2006). Given that our early ancestors were entirely dependent on their physical capacities to survive, physical activity was part of their daily life (e.g., by hunting). Consequently, throughout the (pre-) human evolution, our genetic profile has changed in order to function optimally in physically demanding circumstances (Eaton & Eaton, 2003). However, since the technological advancements in the 20th century, physical activity is no longer a prerequisite to survive. The industrialization allows us and even stimulates us to adopt a physically inactive lifestyle (French, Story, & Jeffery, 2001; Haskell et al., 2007). For example, the most prevalent occupations have shifted from farming and heavy manual factory work to operating automated machines and administrative jobs with a minimum of energy expenditure. In addition to the reduced physical requirements associated with work, environmental changes (e.g., unsafe sidewalks) have led many

individuals to be less likely to walk or cycle for transportation. Moreover, the increase of screen-based behavior (e.g., television viewing, video gaming, internet using) may have decreased individuals' engagement in physical activity during their leisure time (French et al., 2001). It can thus be stated that, nowadays, our genotype is in contrast with our lifestyle (Eaton & Eaton, 2003).

1.3. Health care costs associated with chronic diseases

Suffering from one or more chronic diseases can affect individuals' quality of life. In addition, the high prevalence of chronic diseases in industrialized countries (due to ageing and / or physical inactivity) yields a considerable *economic burden* at the societal level (Naughton et al., 2006; Patrick & Williams, 2012). For example, a study among Irish older adults estimated the health care costs associated with a single chronic condition at €316 per patient per year. The costs may even be much higher given the significant level of co-morbidity (Naughton et al., 2006). Moreover, it has been suggested that three fourths of all health care costs are attributable to chronic diseases that result from unhealthy behaviors such as tobacco use, a poor diet and a lack of physical activity (Patrick & Williams, 2012; Tudor-Locke & Bassett, 2004).

The abovementioned findings highlight the need to consider physical activity promotion as one of the public health priorities, particularly among older adults. Consequently, the general aim of this doctoral thesis was to evaluate the (long-term) effectiveness of physical activity promoting strategies among (older) adults. Before describing the physical activity intervention studies in detail, the following paragraphs provide information on the physical activity health benefits, the recommended physical activity level for health, the outcomes of previously implemented physical activity promoting strategies and the various theoretical frameworks that have been applied in the development of health promoting interventions. The general introduction concludes with the objectives and outline of this thesis.

2. Physical activity

2.1. Definition of physical activity

Physical activity refers to any bodily movement produced by skeletal muscles that increases individuals' energy expenditure (Caspersen, Powell, & Christenson, 1985). The energy expenditure, which is measured in kilocalories, can vary from low to high. This variation does not only occur between individuals but also within individuals in that the degree to which they are physically active fluctuates on a daily basis (Warren en al., 2010). The total amount of calories that are expended by physical activity is influenced by individuals' muscle volume that produces their bodily movements and by the frequency, duration and intensity of the (muscular contractions associated with their) particular physical activity.

Physical activity can not only be described in terms of its frequency, duration and intensity, but also in terms of its type (Kesaniemi et al., 2001; Warren et al., 2010). *Frequency* refers to the number of activity sessions during a specific time period (e.g., per week or per day). *Duration* reflects the time of participation in a single bout of physical activity and is usually expressed in minutes. The *intensity* of

physical activity describes the physiological effort that is associated with the performance of a specific type of physical activity. With respect to its *type*, physical activity can be categorized in many ways, e.g. according to its intensity (mild versus moderate versus strenuous), its willingness (voluntarily versus compulsory), its time period (weekday versus weekend day) or its context. The latter refers to physical activity that occurs while sleeping, at work, during transportation or during leisure time. Leisure-time physical activity can further be divided into different classes such as sports, conditioning, household chores and gardening. The different methods to categorize daily physical activity imply that this concept can be considered as multidimensional.

The term 'physical activity' is often used interchangeably with the terms 'exercise' and 'physical fitness'. Even though they are related to each other, they are different concepts (Caspersen et al., 1985). Whereas physical activity refers to any bodily movement produced by skeletal muscles, *exercise* is (a subcategory of) physical activity that is planned, structured and repetitive. Moreover, individuals who are exercising particularly pursue the maintenance or improvement of their physical fitness.

Physical fitness can be described as a set of characteristics that people have or achieve in order to be able to perform daily tasks and activities with vigor and alertness, without excessive fatigue, and with sufficient energy to enjoy leisure-time pursuits and to meet unexpected difficulties (Caspersen et al., 1985). In contrast with the day-by-day variability of physical activity, physical fitness remains relatively stable over time (Warren et al., 2010). Physical fitness involves components that are health-related such as cardiorespiratory endurance, muscular strength and body composition, and components that are skill-related such as balance, speed and coordination. The health-related components of physical fitness are important for public health whereas the skill-related components are associated with athletic abilities. Individuals' level of physical fitness can be assessed with specific laboratory or field tests, e.g. the six-minute walk test (cardiorespiratory endurance), the skinfold pinch (body composition) or plate tapping (coordination and speed of upper limbs). Physical activity, and thus also exercise, is positively correlated to physical fitness, meaning that the more individuals engage in physical activity (i.e. dose), the higher their level of physical fitness (i.e. outcome / response) will be.

2.2. Dose-response

The *dose-response* relationship is not only valid for individuals' physical fitness but also for the health benefits associated with physical activity (see section 2.3.) (Kesaniemi et al., 2001). In this respect, the dose-response relationship indicates the amount and intensity level of physical activity that is needed to obtain health benefits (e.g., reduced risk of cardiovascular diseases, and optimal levels of blood pressure, lipoproteins and insulin). In particular, the dose reflects the amount of energy that is expended by the performance of physical activity, and is thus determined by its frequency, intensity, duration and type.

The dose-response relationship between physical activity (i.e. dose) on the one hand and fitness and many health outcomes (i.e. response) on the other hand is linear, meaning that larger amounts and higher intensities of physical activity produce greater benefits (Kesaniemi et al., 2001; Pate, 1995). However, with respect to physical fitness as well as many health parameters, there is a diminishing return with higher doses of physical activity meaning that a further increase in activity elicits a smaller response (Figure 1). Higher doses of physical activity produce thus greater but not proportionally greater improvements in fitness and health (Kesaniemi et al., 2001; Pate, 1995). Moreover, the risk of activity-related musculoskeletal injuries increases as physical activity increases.

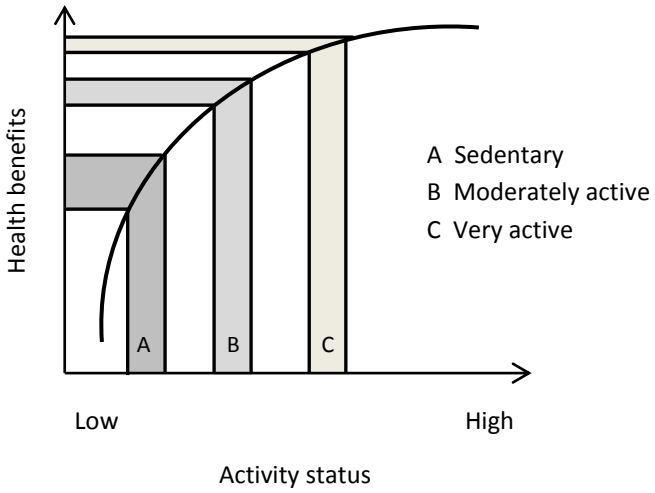

Figure 1. The dose-response curve representing the relationship between individuals' physical activity level and the obtained health benefits (Pate, 1995).

Even though the benefits produced by physical activity of longer duration are well documented, literature includes conflicting evidence concerning the precise shape of the dose-response curves with respect to different health indicators as well as concerning the specific role of physical activity intensity (Haskell et al., 2007; Pate, 1995). Further research on the dose-response relationship between physical activity and health is thus warranted.

2.3. Physical activity health benefits

Overall, the health benefits of physical activity are well established. In addition to eliminating tobacco exposure, moderating alcohol consumption, healthy eating and having a body mass index below 25, engaging in moderate intensity physical activity for 30 minutes each day is considered as a key lifestyle behavior (Patrick & Williams, 2012). It has been stated that individuals who do not comply with these lifestyle behaviors have higher risks of cardiovascular, metabolic and psychological diseases. Moreover, not performing these lifestyle behaviors accounts for 40% of all-cause mortality in industrialized countries (Patrick & Williams, 2012). In particular, regular physical activity plays a fundamental role in the prevention

of chronic diseases such as cardiovascular conditions, diabetes mellitus, cancer, hypertension, obesity, depression and osteoporosis (Haskell et al., 2007; Taylor et al., 2004; Warburton et al., 2006).

2.3.1. Physical health benefits

Increased levels of physical activity and physical fitness have been demonstrated to yield a reduced risk of *cardiovascular mortality* (e.g., stroke, coronary heart disease) and *all-cause mortality* in both men and women, whether or not suffering from a heart condition (Hu et al., 2005a; Oguma & Shinoda-Tagawa, 2004; Warburton et al., 2006). For example, Myers et al. (2004) found that the expenditure of an additional 1000 kilocalories per week due to increased physical activity results in a reduced mortality risk of 20% in a male population. Moreover, a prospective cohort study of Wen et al. (2011) indicated that performing physical activity for 15 minutes each day has a 14% reduced risk of all-cause mortality compared with being inactive. This result is consistent with Warburton et al. (2006) who stated that, due to the graded effect, even small improvements in physical fitness are associated with a substantial reduction in risk of premature death. However, even though a low physical activity level can produce health benefits, Wen and colleagues (2011) found that every additional 15 minutes of daily physical activity further reduces the mortality risk by 4%. Even though physical activity and physical fitness are associated with one another and with all-cause mortality, physical fitness is considered to predict health outcomes more strongly than physical activity (Warburton et al., 2006). In particular, highly fit individuals have at least a 50% reduced risk of mortality compared with low-fit individuals.

Furthermore, both aerobic physical activity and resistance training have been shown to reduce the risk of *obesity* and *metabolic diseases* such as type 2 diabetes (Kay & Fiatarone Singh, 2006; Warburton et al., 2006). For example, Helmrich, Ragland, Leung, and Paffenbarger (1991) demonstrated a 6% decreased risk of non-insulin-dependent diabetes mellitus among men due to a weekly increase in energy expenditure of 500 kilocalories. In addition, an inverse dose-response relationship between leisure-time physical activity and the risk of metabolic syndrome was found in a 60-year old population (Halldin, Rosell, de Faire, & Hellénius, 2007). More specifically, the odds ratio for suffering from the metabolic syndrome in a high leisure-time physical activity group was 0.33 (95% confidence interval: 0.22-0.51) using a low leisure-time physical activity group as reference. Similarly, Elosua et al. (2003) found a significantly decreased concentration (- 15.9%) of low-density lipoproteins in young adults after participating in a 16-week aerobic physical activity program.

Regular physical activity of moderate intensity has also been demonstrated to have a protective effect against the development of different types of *cancer* (Hu et al., 2005b; Warburton et al., 2006). In this respect, Samad, Taylor, Marshall, and Chapman (2005) stated in their meta-analysis that physical activity is associated with a reduced risk of colon cancer. More specifically, a relative risk of 0.78 (95% confidence interval: 0.68-0.91) and 0.71 (95% confidence interval: 0.57-0.88) was found for recreational physical activities in respectively men and women, meaning that men and women who engaged in physical activity during their leisure time had a reduced risk of colon cancer of 22% and 29%, respectively. Furthermore,

there is substantial evidence that physical activity is inversely related to the risk of breast cancer, in particularly among postmenopausal women (Monninkhof et al., 2007).

In addition, regular physical activity can prevent individuals to (further) develop *osteoporosis*, even though there are various non-modifiable risk factors such as age and gender. Osteoporosis is not a life-threatening disease but it considerably increases the risk of bone fractures and diminishes individuals' quality of life (Borer, 2005). Physical activity can be beneficial in that it regulates bone maintenance and stimulates bone formation in addition to strengthening individuals' muscles and improving their balance (and thus reducing the risk of falls). In this respect, a review of Gregg, Pereira, and Caspersen (2000) that was based on prospective and case-control studies among older adults concluded that participation in leisure-time physical activity is associated with a 20% to 40% reduced risk of hip fractures relative to adults who are not regularly engaged in physical activity. However, resistance training and high-impact physical activity (e.g., brisk walking) have been found to produce greater effects on bone mineral density, and accordingly to prevent age-related bone loss more effectively than low-impact sports (e.g., swimming) (Warburton et al., 2006).

Overall, there is a graded linear relationship between the volume of physical activity and the specified health outcomes, meaning that the most physically active individuals are at the lowest risk of health diseases. However, the largest improvements in health are perceived in the least fit individuals who become physically active (Warburton et al., 2006).

2.3.2. Psychological health benefits

Regular physical activity has not only been shown to be beneficial for individuals' physical health, but has also been found to positively influence their psychological well-being. The concept of psychological and subjective well-being is broad-ranging and comprises negative components such as depression, anxiety and loneliness, and positive components such as vitality, life satisfaction and happiness (Diener, 1994). The positive effects of physical activity on the various dimensions of psychological health have been demonstrated among different age groups and among different ethnic populations including men and women (Netz, Wu, Becker, & Tenenbaum, 2005; Penedo & Dahn, 2005).

For example, according to a review of Fox (1999), there is evidence from prospective epidemiological studies that individuals who become or remain physically active or physically fit are less likely to suffer from a *depression*. This is consistent with the study of Sieverdes et al. (2012) who found an inverse association between (various types of) physical activity and depressive symptoms among men of different age groups. More specifically, compared with an inactive population, individuals who performed mild intensities of physical activity were 24% less likely to suffer from a depression and individuals who performed moderate or strenuous intensity physical activity were 51% less likely to display depressive symptoms. Besides the effectiveness of physical activity in the prevention of developing a clinical depression, being engaged in physical activity can be employed as a therapeutic treatment (Barbour &

Blumenthal, 2005; Ströhle, 2009). In this respect, Lawler and Hopker (2001) concluded that the effect of physical activity was similar to that of cognitive therapy.

In addition to the positive influence of physical activity on depressive feelings, research has shown beneficial effects of physical activity on *anxiety* (Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991). More specifically, DiLorenzo and colleagues (1999) found improvements in anxiety and psychological parameters among adults immediately after as well as one year after a 12-week aerobic fitness program. This finding is consistent with Conn (2010) who concluded in a meta-analysis that interventions aiming to increase physical activity among adults can be effective in reducing anxiety symptoms. Even though the overall mean anxiety effect size for two-group comparisons was 0.22 and thus rather low, larger reductions in anxiety were found in studies that targeted only physical activity behavior instead of multiple health behaviors, that included supervised instead of home-based physical activity and that focused on moderate or strenuous intensity instead of mild intensity physical activity.

Furthermore, previous research has shown that regular physical activity can *reduce stress* (Netz et al., 2005). For example, Aldana, Sutton, Jacobson, and Quirk (1996) demonstrated that engagement in moderate intensity physical activity during leisure time is inversely related to individuals' stress level. More specifically, compared with non-active individuals, adult employees who expended more than 3.0 kilocalories per kilogram each day in leisure-time physical activity had a 22% and 38% reduced risk of perceiving moderate and high stress, respectively. Similarly, Norris, Carroll, and Cochrane (1992) found that adolescents who reported greater physical activity levels also reported lower levels of stress, especially those who engaged in high intensity physical activity. Furthermore, Berger and Owen (1988) examined the effect of different types of physical activity on stress reduction. Lower levels of stress, tension, confusion and fatigue were observed in students who participated in aerobic or anaerobic activities whereas individuals engaging in control activities such as fencing only improved in vigor.

Besides the preventing and therapeutic effect of physical activity on mental health problems, physical activity has been shown to yield improvements in *positive emotions* and the positive components of psychological well-being. In this respect, according to a review of Biddle (2001), experimental studies have provided evidence for the positive influence of moderate intensity physical activity on *mood*. Furthermore, in a review concerning physical activity health benefits, McAuley and Rudolph (1995) reported positive associations between physical activity and *psychological well-being* among older adults, with no differences between men and women, and more positive results after engagement in a physical activity program that continued over a longer period of time. Also *self-esteem*, which is considered as an important indicator of well-being, has been found to be positively affected by physical activity, even in the long term (Fox, 1999; McAuley et al., 2005; Schmalz, Deane, Birch, & Davison, 2007). Furthermore, previous qualitative and quantitative research has provided evidence for the short- and long-term positive effect of physical activity on individuals' *quality of life* (e.g., Acree et al., 2006; Ku, McKenna, & Fox, 2007), perceived *happiness* (e.g., Stathi, Fox, & McKenna, 2002; Wang et al., 2012), *vitality* (e.g., Solberg, Hopkins,

Ommundsen, & Halvari, 2012; Wendel-Vos, Schuit, Tijhuis, & Kromhout, 2004), and *cognitive functions* (e.g., Colcombe & Kramer, 2003; Weuve et al., 2004).

2.4. Recommended level of physical activity for health

2.4.1. For adults

As mentioned above, there is a well-established dose-response relationship between physical activity and health, which refers to the graded positive association between physical activity on the one hand and physical fitness and health benefits on the other hand. Considering this dose-response relationship, the American College of Sports Medicine, the Centers for Disease Control and Prevention, and the American Heart Association have formulated *recommended levels of physical activity for health*. In this respect, preventive recommendations specify how adults can promote and maintain their health as well as reduce their risk of chronic diseases and premature mortality by engaging in regular physical activity (Haskell et al., 2007). More specifically, the public health guidelines according to Haskell et al. (2007) state that, in addition to performing daily activities that last less than ten minutes (e.g., walking around at home) or that are of mild intensity (e.g., cooking), healthy adults aged 18 to 65 years need to accumulate at least moderate intensity *aerobic physical activity* for a minimum of 30 minutes on five days each week, in bouts of at least ten minutes, or strenuous intensity aerobic physical activity for a minimum of 20 minutes on three days each week. Combinations of moderate and strenuous intensity physical activity can be performed to meet this recommendation, e.g. swimming (which is moderately intensive) for thirty minutes twice a week and running (which is strenuously intensive) for twenty minutes on two other days during this week.

More recently, the World Health Organization (2010) developed Global Recommendations on Physical Activity for Health that slightly differ from those reported by Haskell et al. (2007). More specifically, the World Health Organization (2010) states that, in order to attain substantial health benefits, individuals should accumulate at least 150 minutes of moderate intensity aerobic physical activity each week, or at least 75 minutes of vigorous intensity aerobic physical activity each week, or an equivalent combination of moderate and strenuous physical activity. Consistent with the recommendations prescribed by Haskell et al. (2007), the aerobic physical activities should be performed in bouts of at least ten minutes (World Health Organization, 2010). However, contrary to the recommendations of Haskell et al. (2007), the recommendations according to the World Health Organization (2010) do not specify a minimum number of days per week on which physical activity should be performed, because there seems to be insufficient scientific evidence to recommend a minimum frequency of physical activity in order to attain health benefits.

In each of the intervention studies presented in this thesis, the physical activity recommendations for health as prescribed by Haskell et al. (2007) were employed. In this respect, individuals who did not attain the physical activity recommendations for health as prescribed by Haskell et al. (2007) were considered as ‘insufficiently active’. Not attaining the physical activity recommendations for health differs

from being sedentary. More specifically, the term 'sedentary' does not only refer to a lifestyle with no or irregular physical activity but also to prolonged bouts of activities that do not increase individuals' energy expenditure above the resting level such as sitting (Pate, O'Neill, & Lobelo, 2008). In the intervention studies presented in this thesis, sitting time was not measured, which makes it inappropriate to use the term 'sedentary'.

Moderate intensity physical activities can be defined as activities that produce noticeable accelerations of the heart rate such as brisk walking or cycling. Strenuous intensity physical activities are activities that cause rapid breathing and a substantial increased heart rate such as running or dancing (Haskell et al., 2007). Even though previous research has indicated that strenuous intensity physical activity produces greater cardio-protective benefits than moderate intensity physical activity, the current recommendation considers moderate and strenuous intensity physical activity as complementary and encourages individuals to engage in physical activity according to their (intensity-) preference and abilities (Haskell et al., 2007; Swain & Franklin, 2006; Williams, 1998).

Consistent with the abovementioned *dose-response* relationship, the recommendation indicates that performing less physical activity than the recommended minimum increases the risk of inactivity-related chronic diseases. On the other hand, performing more physical activity than the recommended minimum provides greater health benefits. The precise amount of physical activity at which individuals perceive the most benefits is determined by different factors such as their age, gender, health status, body composition and *genetic constitution* (Haskell et al., 2007). The influence of specific genotypes as confounders in the relationship between physical activity and health benefits may partly explain the demonstrated inter-individual heterogeneity when evaluating a dose-response to physical activity (Kesaniemi et al., 2001).

In addition to aerobic activities, adults are encouraged to engage in *muscle-strengthening* on at least two (non-consecutive) days each week in order to promote their health (e.g., by lowering the risk of osteoporosis) and in particular to maintain their physical independence (Haskell et al., 2007). In this respect, individuals' strength of the major muscle groups can be developed, increased or maintained by different types of resistance training such as stair climbing and weight bearing with a resistance weight that allows eight to 12 repetitions.

2.4.2. For older adults

Whereas the abovementioned evidence-based recommendations for aerobic physical activity apply to all healthy adults, several modifications and specifications have been formulated for *adults of 65 years or older and for adults aged 50 to 65 years with chronic medical conditions, low fitness levels or functional limitations that affect their physical activity* (Nelson et al., 2007). Those modifications embrace three aspects:

(1) The recommendations prescribe a lower *intensity* level of physical activity for the abovementioned population group. The adult recommendation defines aerobic intensities of

physical activity in absolute terms, i.e. as a metabolic equivalent which expresses the energy cost of a particular physical activity. In particular, one metabolic equivalent represents individuals' energy expenditure while sitting quietly, three to six metabolic equivalents represent moderate intensity physical activities, and more than six metabolic equivalents represent strenuous intensity physical activities. By contrast, the recommendation for older adults defines aerobic intensities of physical activity as relative to individuals' physical fitness (because their fitness level can be low). More specifically, on a ten-point scale, where sitting equals zero and all-effort activity equals ten, moderately intensive physical activity should be a five or six (i.e. noticeable increases in individuals' heart rate and breathing) and strenuously intensive physical activity should be a seven or eight (i.e. large increases in individuals' heart rate and breathing). Given the heterogeneity of fitness levels among older adults, brisk walking can thus be perceived as a moderately or strenuously intensive physical activity;

(2) In addition to exercises that improve individuals' muscle strength and endurance, activities that increase individuals' *flexibility and balance* are recommended in an older population to improve their physical functioning. Activities that maintain or increase individuals' flexibility should be performed at least twice a week in order to maintain the flexibility that is needed for regular physical activity and daily life (e.g., pulling on their socks). Balance exercises should especially be performed among older adults at risk of falls;

(3) The prescribed recommendations are not only *preventive* but also *therapeutic*. Older adults with one or more medical conditions should perform physical activity in a way that the condition is treated effectively and safely (i.e. therapeutic). When chronic conditions prevent individuals to attain the minimum recommended levels for prevention, they should engage in physical activity according to their abilities and conditions, and particularly avoid sedentary behavior. Moreover, older adults who are not physically active at the recommended level should gradually increase their physical activity level.

2.4.3. Other physical activity health recommendations

2.4.3.1. Step-based health recommendations

The abovementioned public health recommendations with respect to physical activity as described by Haskell et al. (2007) are accepted and employed worldwide. The guidelines refer to the minimal level of physical activity that is needed to obtain health benefits and are expressed in terms of physical activity frequency, duration and intensity. The recommendations are based on many epidemiological and intervention research that has primarily relied on self-reports. However, the evolution of objective monitoring using pedometers and accelerometers offers opportunities to communicate physical activity recommendations in terms of steps per day (Tudor-Locke et al., 2011a). In this respect, *step-based guidelines* have been formulated. Consistent with the public health recommendations, they recognize that

'some physical activity is better than no physical activity' and focus on the time spent in moderate-to-strenuous physical activity.

According to Tudor-Locke and Bassett (2004), individuals who take less than 5000 steps a day are considered as having a sedentary lifestyle. Moreover, previous research has shown that taking 7000-8000 steps each day equates minimal amounts of (moderate and strenuous intensity) physical activity during habitual life (Tudor-Locke et al., 2011a). In order to meet the current health recommendations, a number of steps should be taken in addition to these habitual activity levels. Given that the daily recommendation as prescribed by Haskell et al. (2007) is 30 minutes and that moderate intensive walking corresponds with a cadence of 100 steps a minute, a minimum of 3000 steps each day represents a reasonable value for these additional steps. Summing the steps taken during habitual life and the additional steps, the daily step-based recommendation of free-living physical activity that also includes the recommended amount of time spent in moderate-to-strenuous intensity physical activity for healthy adults is *8000 to 11 000 steps each day*.

Healthy older adults typically display slightly lower levels of habitual daily physical activity than healthy adults (Tudor-Locke et al., 2011b). Accordingly, 30 minutes of daily moderate-to-strenuous physical activity accumulated to their daily habitual activities is considered to be equivalent to taking *7000 to 10 000 steps each day* in this population group. For (older) adults suffering from disabilities or chronic diseases that limit their mobility or physical endurance, these recommended numbers of daily steps will probably be unattainable.

Consistent with the abovementioned step-based recommendations for health, Tudor-Locke and Bassett (2004) proposed a gradually increasing *step index* in order to describe pedometer-determined habitual physical activity in adults. This categorization does not take into account the reduction of physical activity levels with advanced age or due to chronic diseases, but it provides a valuable reference scheme. The index distinguishes five incremental categories:

(1) Individuals who take less than 5000 steps each day are classified as *sedentary*. This category can further be divided into *basal activity* (i.e. taking less than 2500 steps each day) and *limited activity* (i.e. taking 2500 to 4999 steps each day);
(2) Individuals who take 5000 to 7499 steps each day are classified as *low active* because this number of steps is typical for individuals' daily activity without additional sports or exercise;
(3) Individuals who take 7500 to 9999 steps each day probably include some volitional physical activities or obtain additional steps due to their occupational activities, and are therefore classified as *somewhat active*;
(4) Individuals who take 10 000 to 12 499 steps each day are classified as *active*;
(5) Individuals who take at least 12 500 steps each day are classified as *highly active*.

Similarly to the abovementioned *dose-response relationship* of physical activity, it has been shown that obtaining a higher number of daily steps or being classified in a higher step-based category is associated with improved outcomes on various health parameters. For example, research has demonstrated that taking more steps a day results in positive changes in (1) individuals' risk factors to

develop chronic diseases, e.g. a lower body mass index, a smaller waist circumference, a lower percentage of body fat, a lower likelihood to suffer from the metabolic syndrome, a better functioning of their immune system, higher levels of their bone density, and lower levels of their blood pressure, low density lipoproteins and fasting glucose; and in (2) individuals' psychological health, e.g. lower levels of depressive feelings, lower perceptions of fatigue and higher levels of subjective quality of life (Tudor-Locke & Bassett, 2004; Tudor-Locke et al., 2011a; Tudor-Locke et al., 2011b). However, consistent with the public health recommendations as described by Haskell et al. (2007), the specific shape of the dose-response curves related to step-defined physical activity varies according to the specific health outcome.

2.4.3.2. Comparing different physical activity recommendations

The recommendation of 10 000 steps a day is gaining popularity within the media. This guideline is simple, easy to remember and provides a concrete goal for individuals to increase their physical activity level (Tudor-Locke & Bassett, 2004). Even though it may be difficult to attain the step-based health recommendation of 10 000 steps each day for older adults or for adults with chronic diseases, it appears to be a reasonable estimate of daily activity for healthy adults.

However, the following three shortcomings should be noted with respect to the step-based public health recommendation compared with the health recommendation as described by Haskell et al. (2007):

(1) The public health recommendation of 30 minutes of moderate intensity physical activity on five days a week reflects a recommendation to be *active over and above a minimal level of daily activity*. By contrast, the step-based recommendation reflects all physical activities performed during the day including activities that last less than ten minutes or that are of mild intensity such as stair climbing or cooking (Tudor-Locke & Bassett, 2004);

(2) Whereas the public health recommendations as described by Haskell et al. (2007) point out the importance of performing physical activities of *moderate or strenuous intensity*, the step-based recommendations do not allow to make a distinction between the different intensities of physical activity;

(3) Whereas the public health recommendations as described by Haskell et al. (2007) take into account *all types of physical activity*, calculations for step-based recommendations only rely on activities that generate steps. In addition to the activities that generate steps, there is a wide range of physical activities that do not generate steps such as swimming, cycling or upper body movements. Various studies have provided conversion methods to represent non-ambulatory activities in terms of steps (Tudor-Locke et al., 2011b). However, there is a lack of consistency with respect to the translation of non-ambulatory physical activities into a number of steps. For example, Lubans, Morgan, Collins, Boreham, and Callister (2009) suggested that being physically active at a heart rate of 65-75% of individuals' maximal heart rate corresponds to approximately 140 steps per minute. Furthermore, Miller, Brown, and Tudor-Locke (2006) suggested adding 200 bonus steps for every minute of non-ambulatory activities. By contrast,

De Greef, Deforche, Tudor-Locke, and De Bourdeaudhuij (2010) instructed participants in pedometer-based interventions to add 150 steps to their daily physical activity for every minute that they engaged in cycling or swimming.

2.4.4. Prevalence of physical (in-) activity

2.4.4.1. Prevalence of physical activity

Despite the occurrence of multiple physical activity guidelines, there is a large inter-individual variety of *physical activity patterns* in the Western society, including Europe, and more specifically Belgium and Flanders (TNS Opinion & Social, 2010). With respect to *organized sport activities*, half of the Belgian population reports being engaged in sports at a regular basis (i.e. five times a week or more; 16%) or with some regularity (i.e. once a week or more; 34%). By contrast, 50% of the Belgian population indicates that they participate in organized sports seldom (22%) or never (28%). Men are found to be more active in organized sports than women, and participation in physical activity and exercise are found to decrease with advanced age (TNS Opinion & Social, 2010). In this respect, respectively 10% and 8% of the Belgian citizens aged 55 to 69 years and aged over 70 years are engaged in organized sports at a regular basis. On the other hand, respectively 51% and 66% of them indicate that they never perform sport activities.

A slightly larger proportion of the Belgian citizens are engaged in *non-organized* (i.e. informal) *sport activities* such as walking, cycling and gardening compared with organized sports. More specifically, respectively 21%, 36%, 24% and 19% of them indicate to perform non-organized physical activities at a regular basis, with some regularity, seldom and never. Consistent with organized sport activities, participation in non-organized physical activities reduces with advanced age. However, there are no differences between men and women (TNS Opinion & Social, 2010).

Similarly to the abovementioned results based on a Belgian population group, a survey among adolescents and adults in *Flanders* indicated that 51.2% of this population group engages in physical activities at a regular basis (Lievens & Waege, 2011). More specifically, it is stated that 5.7% of them participate in sports and exercise for less than one hour a week, 18.7% of them participate in sports and exercise for one to three hours a week and 27.2% of them participate in sports and exercise for more than three hours a week. The results were also confirmed by Scheerder et al. (2011), who studied the participation rates in sport and exercise among Flemish older adults. More specifically, the results of the survey indicated that 55.4% of the Flemish adults aged 55 years or older participated in sports or exercise during the previous year. Almost three quarters of them have reported to engage in sport activities at a regular basis, i.e. weekly.

2.4.4.2. Prevalence of physical inactivity

The abovementioned results suggest that a substantial proportion of the Belgian, and in particular the Flemish population, engages in physical activity and sports at a (more or less) regular basis. Nevertheless, almost half of the Belgian and Flemish adults aged between 18 and 75 years do not attain the

recommended physical activity levels for health as prescribed by Haskell et al. (2007) (Bauman et al., 2009; Philippaerts et al., 2006; TNS Opinion & Social, 2010; Varo et al., 2003). In general, a larger proportion of women than men do not meet the public health guidelines (Bauman et al., 2009). For example, Philippaerts et al. (2006) indicated that, within the population of adults aged 40 to 44 years, 50% of the male Flemish adults fail to meet the public health recommendations whereas 61% of the female Flemish adults fail to meet the guidelines. Moreover, the physical activity participation rates are found to decline with age, especially with respect to high intensity physical activity (Bauman et al., 2009). In this respect, Lefevre and colleagues (2002) showed that the proportion of Flemish male individuals attaining the minimum recommended physical activity level decreases from 67% in 15 to 19 year old adolescents to 49% in 20 to 59 year old adults and to 17% in adults of 60 years or older. In addition to being female and being older, the following socio-demographic characteristics are found to be associated with lower physical activity levels: a lower educational level, a higher body mass index, living in a bigger community or town, being in a relationship and a worse self-rated health status (Bergman, Grjibovski, Hagströmer, Bauman, & Sjöström, 2008; Varo et al., 2003).

2.4.5. Physical activity barriers

As mentioned above, even though physical activity yields numerous health benefits, only a minority of the Western population does attain the recommended minimum of 30 minutes of moderate intensity physical activity on five days a week or 20 minutes of strenuous intensity physical activity three times a week. Among European citizens, the most frequently reported reasons for engagement in physical activity are health improvement, fitness enhancement, appearance, relaxation and enjoyment (TNS Opinion & Social, 2010). On the other hand, perceiving a *shortage of time* is the most commonly reported reason why people fail to participate in physical activity. Moreover, approximately half of the Belgian citizens agree with the statement 'Being physically active does not really interest me; I would rather do other things with my spare time', which suggests that they *lack interest and motivation* to participate in physical activity (TNS Opinion & Social, 2010). Furthermore, it appears that physical activity is perceived as a less important aspect of individuals' lives when they get older (TNS Opinion & Social, 2010).

Consistent with the described physical activity barriers among European and in particular Belgian citizens, Scheerder et al. (2011) indicated that, among Flemish adults aged 55 years or older, the following four reasons are reported most frequently to not participate in physical activity: *inappropriate weather* conditions, a lack of time, feelings of *insufficient competence* (e.g., suffering from health problems, feeling not physically fit or skilled enough) and a lack of interest and motivation. According to Moschny, Platen, Klaaßen-Mielke, Trampisch, and Hinrichs (2011) who examined perceived barriers to physical activity in German older adults, a *lack of company* may contribute to physical inactivity in this population group. Moreover, with increasing age, a lack of perceived competence due to health conditions, motivation and accessibility of facilities appear to be more frequently reported (Scheerder et al., 2011; Schutzer & Graves, 2004). In general, perceived barriers to physical activity can be psychological, administrative, health-related

or related to (a lack of) knowledge (O'Neill & Reid, 1991; Schutzer & Graves, 2004). Given that 87% of the (older) adults have at least one barrier that prevents them to engage in physical activity, the perceived barriers should be considered in order to develop and implement effective physical activity promotion strategies (O'Neill & Reid, 1991).

3. Frequently used physical activity promoting strategies

Despite the well-established health benefits associated with regular physical activity, only a minority of the Western population attains the recommended physical activity level of 30 minutes of moderate intensity physical activity on five days a week or 20 minutes of strenuous intensity physical activity three times a week (Philippaerts et al., 2006). Hence, physical activity promotion has emerged as a major public health priority.

A large number of physical activity promoting strategies have been evaluated. Positive results have been found by implementing physical activity interventions in a specific environmental *context* such as health care setting, a workplace and a community (Hillsdon, Foster, Cavill, Crombie, & Naidoo, 2005). Irrespective of the context in which the physical activity interventions have been implemented, different physical activity promoting *strategies* have been shown to be effective in increasing individuals' physical activity level, particularly in the short term (Van Der Bij, Laurant, & Wensing, 2002). Below, a short description of frequently used physical activity promoting strategies is provided, paying special attention to the physical activity promoting strategies that were chosen for the interventions presented in this thesis. However, literature on physical activity promotion provides a broader range of effective strategies that can be implemented in different contexts and population groups.

King, Rejeski, and Buchner (1998) indicated in their review the effectiveness of *group-based* and *center-based* programs in promoting physical activity among different population groups. More specifically, previous research has demonstrated improved physical activity and physical fitness as well as high levels of short-term adherence to the interventions (~ 75%). The group-based and structured fitness interventions reviewed by King et al. (1998) focused on various types of physical activity such as aerobic training, fitness, dancing classes, walking and resistance training. However, each of them involved multiple supervised sessions per week.

Besides the structured fitness programs, *lifestyle interventions* have been shown to be effective in promoting physical activity (Dunn, Andersen, & Jakicic, 1998a; Taylor et al., 2004; Van Der Bij et al., 2002). Lifestyle interventions encourage individuals to incorporate physical activity into their daily life (e.g., by active transportation). The individuals are contacted regularly by a physical activity counselor, either face-to-face, by phone or by email. They are provided informational feedback, supported to change their behavior and stimulated to continue their improved physical activity pattern. In particular, the individuals are taught cognitive and behavioral skills (e.g., planning, barrier identification) to maintain their physically active lifestyle after the intervention has ended rather than being supervised continuously by a fitness instructor in a structured setting. Given that lifestyle interventions involve only limited supervision, this

physical activity promoting strategy has been found to be more cost-effective than fitness programs, which enhances the generalizability of lifestyle interventions to the wider community (Sevick et al., 2000). Moreover, lifestyle interventions appear to be more successful than structured interventions in maintaining high participation rates and increased physical activity levels in the long term (Dunn et al., 1998b; Opdenacker, Boen, Coorevits, & Delecluse, 2008).

Even though lifestyle interventions consist of a limited number of contact moments, they are still time- and labor-intensive. Consequently, less time-consuming counseling procedures have been evaluated. In this respect, systematic reviews have studied the effectiveness of *exercise referral schemes* in improving physical activity participation among sedentary or inactive adults (e.g., Dugdill, Graham, & McNair, 2005; Morgan, 2005; Williams, Hendry, France, Lewis, & Wikinson, 2007). A referral scheme can be defined as a referral to organized physical activity sessions including assessment, monitoring and supervision in public leisure facilities. Referral usually occurs by a general practitioner or a primary care clinician, after a brief consultation. Physical activity referral by health professionals is considered as a potential physical activity promoting strategy because general practitioners are frequently in contact with most patients and are assumed to be influential with respect to individuals' behavior change (Dugdill et al., 2005). Physical activity referral has been shown to increase the number of individuals doing moderate intensity physical activity. Referral schemes appear to be especially effective among older adults, among individuals who are not sedentary but already slightly physically active and among those who are overweight (Morgan, 2005; Stathi, McKenna, & Fox, 2003; Williams et al., 2007).

However, the effect size of referral schemes has been found to be relatively small, i.e. only one out of 17 referred individuals has changed his / her physical activity status from inactive to moderately active. Furthermore, referral by a primary care practitioner to locally-organized physical activity programs usually succeeds in the short term but is limited in terms of long-term engagement in physical activity. In particular, it has been stated that the increased physical activity levels are not maintained beyond 12 weeks (Morgan, 2005; Williams et al., 2007). In addition, adherence to the programs has been found to be relatively low in that approximately 80% of the participants who initially took up exercise referral dropped out before the end of the program (Dugdill et al., 2005; Williams et al., 2007). The limited success of referral schemes can be attributed to the individuals' psychological make-up (e.g., poor time management, lack of self-efficacy, lack of social support) or to structural characteristics of the physical activity sessions (e.g., intimidating environments, inadequate supervision, inconvenient opening hours) (Williams et al., 2007). Moreover, according to Stathi, McKenna, and Fox (2003), physical activity referral can only yield increased physical activity levels when the general practitioner pronounces appropriate recommendations, when enthusiastic and experienced physical activity instructors provide professional help and support, and when the physical activity programs are attractive. In particular, given that each individual has different reasons and ambitions for adopting and maintaining physical activity behavior, programs should meet individuals' personal needs and preferences.

Providing *walking programs* constitutes another effective and feasible approach to introduce sedentary or inactive individuals to regular physical activity (Ogilvie et al., 2007). Walking is the preferred, the most popular and the most frequently performed type of physical activity among all adults (Sugden et al., 2008; Taylor et al., 2004). Given that walking is easily accessible, implementing walking interventions can be considered as an appropriate way to increase individuals' physical activity behavior. Previous research has provided evidence for the effectiveness of walking programs, delivered either at the individual level or at the group level (Ogilvie et al., 2007). The most positive results have been found among the least physically active adults and those who are motivated to change their behavior, with increases of 60 minutes of walking per week on average.

However, results of walking interventions have usually been limited to a specific population such as obese individuals or older adults and to an isolated setting such as a workplace. Therefore, they can not be generalized to the wider community. Moreover, walking programs substantially vary with respect to their procedure, e.g. whether or not pedometer-based, whether or not theoretically-grounded, the degree of supervision, the program duration etc. (e.g., Fisher & Lee, 2004; Gusi, Reyes, Gonzales-Guerrero, Herrera, & Garcia, 2008; Lamb, Bartlett, Ashley, & Bird, 2002; Lee, Arthur, & Avis, 2007; Parkatti, Perttunen, & Wacker, 2012; Pelssers et al., 2013; Tudor-Locke, Myers, Bell, Harris, & Rodger, 2002). The variety in implementation strategy, program development and procedures makes it difficult to draw strong and unambiguous conclusions on the effectiveness of walking schemes. Moreover, according to a review of Ogilvie et al. (2007), previous studies on walking interventions have failed to demonstrate long-term effects.

4. There is nothing more practical than a good theory [a]

Despite the large number of health promoting programs that demonstrate positive outcomes on physical activity and well-being in the short term, intervention studies have failed to show consistency with respect to their effectiveness in the *long term* (Taylor et al., 2004). This may be caused by the lack of an underlying theory in many of the implemented physical activity promoting strategies, especially because previous research has underscored the importance of a theoretically-grounded framework. More specifically, increasing evidence suggests that interventions aiming to enhance public health are more effective when they are based on social and behavioral science theories than when they lack a theoretical base (Glanz & Bishop, 2010; Hillsdon et al., 2005). A variety of theoretical frameworks have been employed in the development of interventions to promote health behavior such as physical activity, e.g. Social-Cognitive Theory (Bandura, 1986), Theory of Planned Behavior (Ajzen, 1991), Transtheoretical Model of Change (Prochaska & DiClemente, 1983) and Self-Determination Theory (Deci & Ryan, 1985). The abovementioned theories are described in the following paragraphs.

[a] Annotation: The psychologist Kurt Lewin (1951, p. 169) pointed out the need to integrate theory and practice. By citing 'There is nothing more practical than a good theory', he encouraged (1) applied scientists to provide facts that needed to be conceptualized in a coherent manner and to make use of available theoretical constructs; and (2) theorists to develop conceptual frameworks that can be used to deal with practical issues.

4.1. Social-Cognitive Theory

The Social-Cognitive Theory advances a multifaceted causal structure in which self-efficacy beliefs operate together with knowledge, goals, outcome expectations and perceived environmental facilitators and impediments in the regulation of human motivation, behavior and well-being (Bandura, 2004). Perceived self-efficacy is the focal determinant in the causal structure because it affects motivation and action both directly and through the other determinants (Bandura, 1998).

Self-efficacy refers to the belief of one's capabilities to succeed in specific situations, e.g. running eight kilometers three days a week. It influences the choices people make and the courses of action they pursue in that individuals tend to select activities in which they feel competent and confident. Moreover, it is assumed that individuals with a high level of self-efficacy, i.e. those who belief they can perform well, are more likely to master than to avoid challenging tasks. According to Bandura (1986), there are four main sources of self-efficacy:

(1) The most effective way to develop self-efficacy is through *mastery experiences*. Success and overcoming obstacles by effort strengthen one's sense of self-efficacy whereas failure or experiencing only easy successes can undermine one's self-efficacy beliefs. For example, by following a scheme with a progressively increasing running distance (e.g., up to eight kilometers), one will experience feelings of mastery, and therefore be more confident to obtain his / her goal;

(2) Seeing people similar to oneself succeed by sustained effort raises individuals' beliefs that they too possess the capabilities to master comparable activities (i.e. *social modeling*). For example, when one is participating in running sessions together with other people who pursue the same eight-kilometer goal or when one's sister has succeeded in running eight kilometers after following the same running schedule, one's confidence to succeed will probably increase;

(3) Individuals' self-efficacy may be reinforced through *social persuasion*, i.e. individuals can be persuaded by others to believe that they have the appropriate skills and capabilities to succeed. Verbal encouragements may help individuals to focus on self-improvement and to overcome self-doubt. For example, one's self-efficacy level will be higher when his / her partner regularly praises his / her progress through the different levels of the running program;

(4) Self-efficacy beliefs can be influenced by the way feelings and emotions are perceived or interpreted (i.e. *psychological response*). Learning how to minimize stress and optimize a positive mood can improve one's sense of self-efficacy. For example, one's level of stress will probably be reduced when he / she focuses on the pleasure and social contact that are associated with the running sessions rather than on the running competition that is planned.

Although self-efficacy plays a key role in the prediction of behavior, the Social-Cognitive Theory has postulated knowledge, goals, outcome expectations and perceived environmental facilitators and

impediments as additional important determinants in the regulation of motivation and behavior. Adequate *knowledge* on health benefits and risks that are related to a particular behavior is recognized as a precondition of change in many theories on health behavior. People will be less likely to change their behavior when they lack knowledge on the way their lifestyle affects their health. However, additional influences are needed in order to adopt and maintain behavior changes. Another process that has an impact on health behavior is *goal-setting*. More specifically, individuals monitor their behavior and react positively or negatively to their performance, depending on how they compare this performance to their goal aspirations. Goals are affected by efficacy beliefs but also contribute independently to behavior. Individuals' belief on the outcome of their behavior constitutes another important determinant of health behavior, either directly or through goal-setting. *Outcome expectations* refer to physical effects associated with one's behavior (i.e. pleasure or pain), social reactions (i.e. approval or disapproval by significant others) and self-evaluative reactions to one's behavior (i.e. self-satisfaction and self-worth or self-dissatisfaction). Finally, health behavior can be affected by perceived (personal or situational) *facilitators* (e.g., a friend is joining you during your running session) *and barriers* (e.g., rainy weather). If there would be no obstacles to overcome, every behavior should be easy to perform and every individual should be totally efficacious. The mutual relationships between the abovementioned determinants of health behavior according to the Social-Cognitive Theory are displayed in Figure 2.

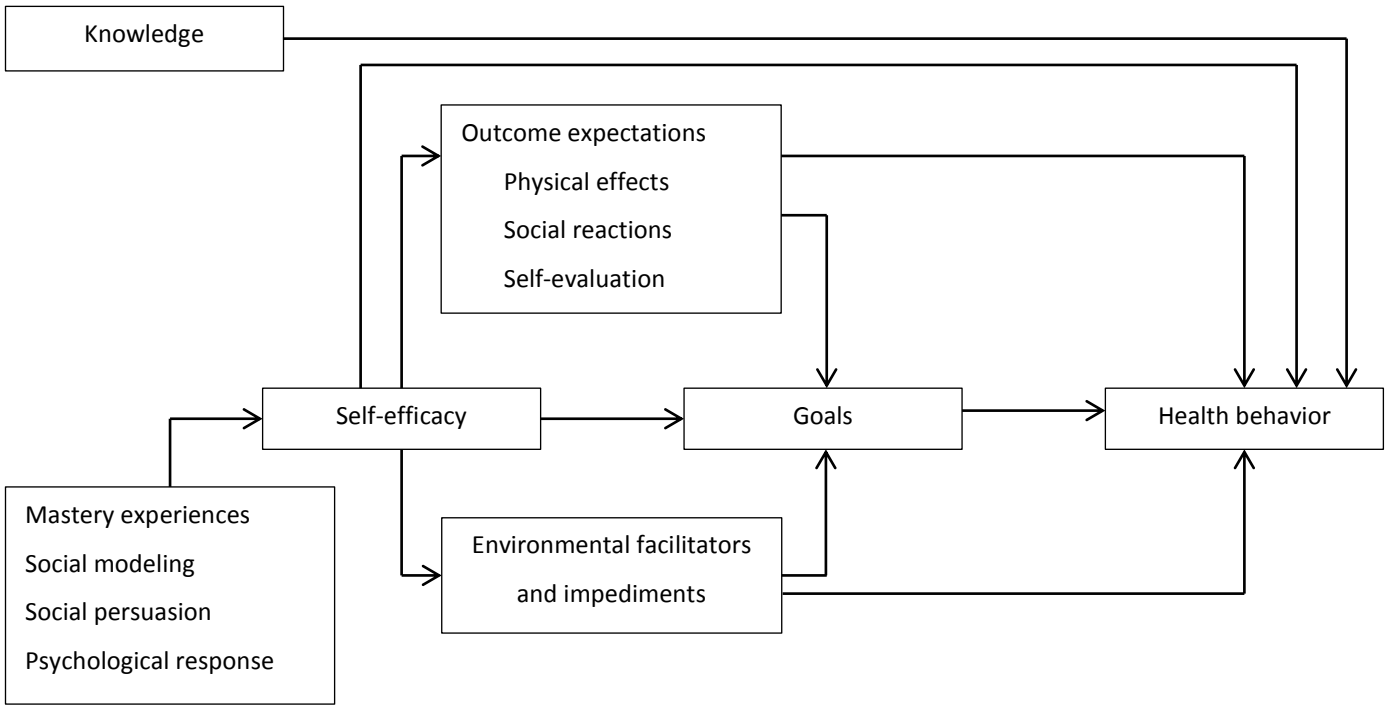

Figure 2. Determinants of health behavior according to the Social-Cognitive Theory (Bandura, 2004).

Physical activity interventions based on the framework of the Social-Cognitive Theory have been shown to be effective among different population groups (e.g., Dunn et al., 1998a; Griffin-Blake & DeJoy, 2006; Ince, 2008; Rogers et al., 2004). However, despite the associations between the proposed determinants of health behavior, mainly self-efficacy beliefs have been found to be predictive for physical activity behavior (e.g., Brassington, Atienza, Perczek, DiLorenzo, & King, 2002; Dishman et al., 2004; Sniehotta, Scholz, & Schwarzer, 2005). Moreover, self-efficacy appears to be essential not only in the adoption but also in the maintenance of physical activity (McAuley, Jerome, Elavsky, Marquez, & Ramsey, 2003).

Besides explaining individuals' behavior in terms of the interplay between their characteristics, their behavioral motivation and environmental influences, the determinants and processes proposed by the Social-Cognitive Theory provide the foundation for individuals' well-being. In this respect, self-efficacy beliefs can affect one's thoughts and emotional reactions. Specifically, a high level of self-efficacy yields feelings of confidence and calmness in approaching difficult tasks whereas a low level of self-efficacy may result in anxiety, stress and depression because tasks are perceived harder as they are.

4.2. Theory of Planned Behavior

The Theory of Planned Behavior states that attitudes, subjective norms and perceived behavioral control shape individuals' intentions (Ajzen, 1991). According to the theory, *behavioral intentions* play a key role in the prediction of behavior. They refer to an individual's readiness to perform a behavior and are considered to directly influence behavior. Moreover, they are an indication of how hard people are willing to try and of how much of an effort they are planning to exert. There are three antecedents of behavioral intention, i.e. attitudes towards a particular behavior, subjective norms and perceived behavioral control.

Attitudes reflect the degree to which individuals evaluate the behavior positively or negatively. The more favorable one's attitudes towards the behavior, the stronger the individual's behavioral intention will be. Attitudes are determined by behavioral beliefs, which can be defined as the subjective probability that performing the behavior will produce the expected outcomes. For example, an overweight women can evaluate aerobic classes very positively (i.e. attitude) because she believes that this is helpful to lose weight (i.e. behavioral belief).

Subjective norms refer to the perceived social pressure (not) to engage in a particular behavior. The more individuals perceive approval of a particular behavior by significant others, the more likely they will perform that behavior. Subjective norms are influenced by a set of accessible normative beliefs with respect to the expectations of others' (dis-) approval of the behavior. For example, when one's colleagues are athletic and fit persons, he / she will probably feel ought to join them during their daily walk after lunch.

Finally, *perceived behavioral control* reflects individuals' perception of the ease or difficulty to perform a particular behavior, e.g. an older person who wants / intends to go for a 30-minute walk every day. This perception varies across situations and actions and can influence behavior either directly or through behavioral intentions. Perceived behavioral control is determined by control beliefs, which refer to

factors that can facilitate or impede the behavior (e.g., perceived health, weather conditions, company during the walk, planned activities). This antecedent was included in the framework of the Theory of Planned Behavior in order to allow prediction of behaviors that are not completely volitional, and thus to explain why intentions do not always predict behavior. Furthermore, perceived behavioral control is expected to moderate the effect of intention on behavior. More specifically, a favorable intention should yield behavioral actions only when perceived behavioral control is strong. For example, the older person will only go for a 30-minute walk when he / she feels healthy, when the weather conditions are favorable, when his / her partner is joining him / her and when no other activities are planned. Consequently, according to the Theory of Planned Behavior, performance of a behavior is a joint function of intentions (when the behavior is volitionally controlled) and perceived behavioral control (when volitional control over the behavior declines). The interplay between the determinants of individuals' behavior according to the Theory of Planned Behavior is shown in Figure 3. It should be noted that the relative importance of attitudes towards a behavior, subjective norms and perceived behavioral control in the prediction of intention can vary across different behaviors and situations.

Previous studies have demonstrated the effectiveness of physical activity interventions based on the Theory of Planned Behavior (e.g., Armitage, 2005; Blue, 2007; Conn, Tripp-Reimer, & Maas, 2003; Mummery, Spence, & Hudee, 2000). However, results on (long-term) behavioral changes are inconsistent (e.g., Armitage, 2005; Chatzisarantis & Hagger, 2005). Perceived behavioral control is the antecedent that has been found to contribute the most to the prediction of behavioral intentions and actual physical activity behavior (e.g., Armitage, 2005; Godin & Kok, 1996).

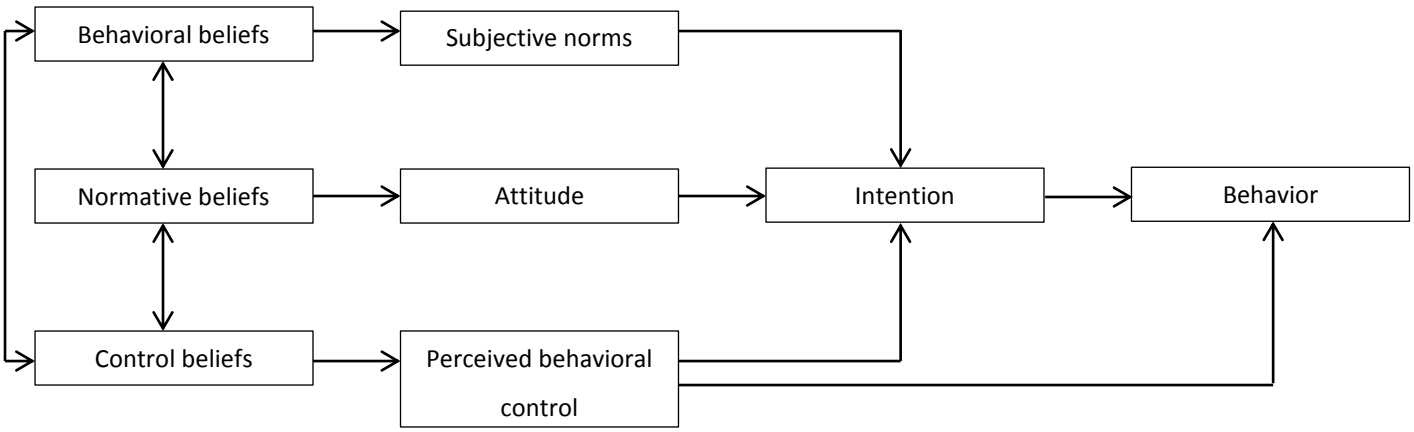

Figure 3. Determinants of health behavior according to the Theory of Planned Behavior (Ajzen, 1991).

4.3. Transtheoretical Model of Change

The Transtheoretical Model is a phase-specific model of intentional behavior change that focuses on individuals' decision making (Prochaska & DiClemente, 1983). The model provides a coherent and cyclical framework to understand one's readiness to adopt and maintain a particular behavior (Figure 4).

More specifically, according to the theory, individuals pass through a series of stages in order (to have the intention) to modify their problem behavior (e.g., overeating, binge drinking, being inactive) or to acquire a positive behavior (e.g., physical activity engagement) (Marshall & Biddle, 2001). Consequently, behavior is considered as a dynamic rather than an 'all or nothing' phenomenon.

The *precontemplation phase* refers to the lack of intention to take action in the foreseeable future, i.e. within the next six months. Individuals in this phase may be un(der)informed about the risks of their (for example, drinking or being inactive) behavior or they may doubt about their ability to change. They usually ignore the need to change and avoid thinking or talking about the particular behavior.

Individuals in the *contemplation phase* are thinking about changing and are intending to change within the next six months. They recognize the benefits associated with the behavior but are also aware of its detriments. An (im-) balance between the benefits (e.g., the health-related benefits of physical activity) and detriments (e.g., the need to spend time and money when engaging in aerobic classes) of changing can produce ambivalence, and accordingly keep individuals in this phase for a considerable period of time.

The *preparation phase* is the stage in which individuals are ready to change, and are deciding and planning to change their behavior in the near future, i.e. within the next month. They have typically already undertaken action during the past year such as consulting a self-help booklet, joining health classes or meeting a counselor. Furthermore, they usually have a plan of action, but they may not be entirely committed to their plan. For example, an individual can be situated in the preparation phase when he / she has already printed the 'start to run' program but has not yet gone for a run.

Individuals in the *action phase* have actively worked towards the desired behavior by modifying their environment or their lifestyle within the past six months. For example, an individual who is going for a 20-minute run three times a week since two months can be situated in the action phase. Whereas the action phase is the starting point of many theories on behavior change, individuals in this phase are half way through their process of change according to the Transtheoretical Model. In order to be allocated to the action phase, individuals should attain a specific criterion which is recognized by professionals as sufficiently to reduce health risks, e.g. performing 30 minutes of moderate intensity physical activity on five days a week or performing 20 minutes of strenuous intensity physical activity three times a week.

In the *maintenance phase*, individuals have attained the preconceived criterion of behavioral change for six months or longer. At this point, they are more confident to continue their behavioral change and need to exert less effort in engaging in change processes.

Individuals can fall back into their old behavior in every phase. However, they are most vulnerable to *relapse* to an earlier stage when they are in the action phase. On the other hand, they are less tempted to relapse once they have maintained the desired behavior for six months or longer (i.e. when they are in the maintenance phase). When the particular behavior becomes part of the individuals' lifestyle or personality, they leave the cyclical pattern of stages of change with respect to this behavior.

In order to progress through the stages of change, individuals make use of different *processes of change* (Prochaska & DiClemente, 1983; Prochaska, Velicer, DiClemente, & Fava, 1988). In the earlier stage

transitions, individuals usually employ experiential processes such as increasing the awareness of and knowledge about the problem behavior, arousing emotions associated with the behavior, assessing the impact of the behavior on the environment (i.e. social reappraisal), examining environmental opportunities to decrease the problem behavior and evaluating cognitions and emotions regarding themselves (i.e. self-reappraisal). In the later stage transitions, the following behavioral processes are applied: rewarding positive behavioral changes, seeking for supportive relationships, substituting the problem behavior by an alternative positive behavior, controlling stimuli that may trigger relapse, and choosing and committing to a course of action to change the behavior.

In addition to the processes of change, *decisional balance* plays an important role in the transition between the different stages of change. This construct refers to the (importance of) individuals' relative weighting of the pros and cons associated with behavioral change (Janis & Mann, 1977). By progressing through the different stages of change, the decisional balance shifts from an overweight of the pros in favor of maintaining the unhealthy behavior to an overweight of the pros in favor of changing the behavior.

The Transtheoretical Model also integrates elements of other theories with respect to behavioral changes, e.g. the self-efficacy concept of Bandura's Social-Cognitive Theory (1986). As mentioned above, self-efficacy reflects individuals' situation specific confidence to cope with high-risk situations (e.g., bad weather conditions) without relapsing to their unhealthy behavior (e.g., transportation by car instead of by bike). In the earlier stages of change, individuals' temptation to engage in the unhealthy behavior is greater than their self-efficacy to abstain. On the other hand, feelings of self-efficacy overweigh feelings of temptation in the action and maintenance phase.

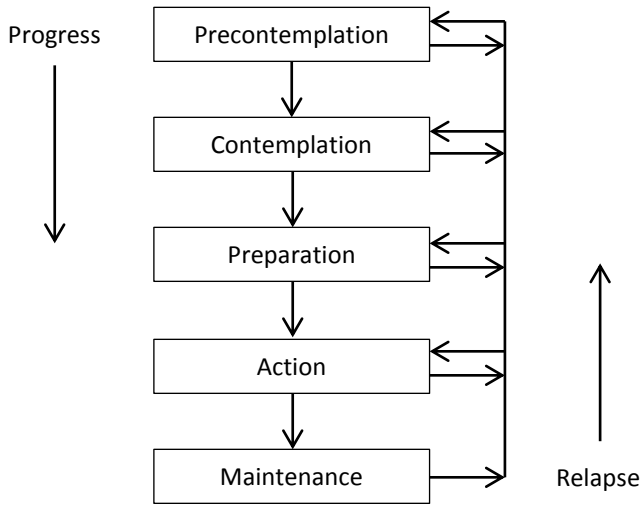

Figure 4. Stages of behavioral change according to the Transtheoretical Model of Change (Prochaska & DiClemente, 1983).

The Transtheoretical Model has been applied to a wide variety of problem behaviors including physical inactivity (Velicer, Prochaska, Fave, Norman, & Redding, 1998). The model postulates that (physical activity) programs should be stage-specific and should approach individuals according to their readiness to

change in order to be effective. For example, individuals who are situated in the earlier stages of change should be informed on the benefits of the particular behavior rather than being stimulated to think about planning their behavioral actions. The Transtheoretical Model is a popular approach among health clinicians. Nevertheless, research has shown that stage progression does not necessarily result in increased physical activity (e.g., Cardinal & Sachs, 1994). Moreover, little evidence has been found that interventions based on the stages of change are more effective than those that are not stage-specific, especially in the long term (e.g., Adams & White, 2003; Dunn et al., 1997; Loughlan & Mutrie, 1995; Naylor, Simmonds, Riddoch, Velleman, & Turton, 1999; Prochaska et al., 1994).

4.4. Self-Determination Theory

4.4.1. Basic psychological needs

The Self-Determination Theory (Deci & Ryan, 1985) provides a comprehensive and integrative framework for the understanding of motivational regulation, human behavior and optimal functioning (Figure 5; Hagger & Chatzisarantis, 2007). Central within this theory is the postulation that individuals possess three basic psychological needs that are essential for their growth, integrity and well-being: the need for autonomy, the need for competence and the need for relatedness (Ryan & Deci, 2000). Considering individuals' innate tendency to strive to personal development, these needs are assumed to be inherent to human nature and hence to operate across culture and time (Deci & Vansteenkiste, 2004; Patrick & Williams, 2012; Vansteenkiste, Niemiec, & Soenens, 2010).

The *need for autonomy* reflects the desire to be the origin of one's own behavior. It involves a sense of choice, personal control and self-endorsement. The need for autonomy can be satisfied by the following strategies: focusing on task-oriented rather than ego-oriented goals (e.g., running ten kilometers without taking a rest instead of running ten kilometers in a shorter time than your friend), encouraging individuals to initiate actions for their own reasons, minimizing pressure by using autonomy-supportive language (e.g., pronouncing 'may' instead of 'must'), acknowledging individuals' perspective, providing informational feedback and a meaningful rationale for given advice and using client-centered strategies such as exploring options.

The *need for competence* implies the pursuit of experiencing mastery and success within a challenging environment. It refers to individuals' striving to attain desired outcomes in order to feel a sense of efficacy. Fulfilling the need for competence may be particularly relevant in the context of failure or uncertainty and can be realized by providing structure, helping individuals to develop clear expectations, formulating challenging but realistic goals, identifying barriers and drafting a plan to solve them (e.g., cycling on an ergometer bike instead of cycling outside in case of rainy weather), pronouncing positive feedback and reinforcing self-motivational statements. Applications of the Self-Determination Theory have provided empirical evidence that feelings of competence can only emerge when individuals are fully autonomous and willing to consider behavior change (Patrick & Williams, 2012; Vansteenkiste et al., 2010).

Finally, the *need for relatedness* refers to the experience of supportive relationships and the reciprocal concern for meaningful others. It reflects the tendency to interact with, to be connected to and to feel a sense of belongingness for other individuals. The perceived relatedness support fluctuates as a function of the interpersonal environment and can be supported by demonstrating understanding and acceptance, showing unconditional regard, exploring individuals' needs, using non-judgmental and positive language, and creating an empathetic, warm and open atmosphere (e.g., by active listening including verbal communication strategies such as paraphrasing and non-verbal communication strategies such as eye contact).

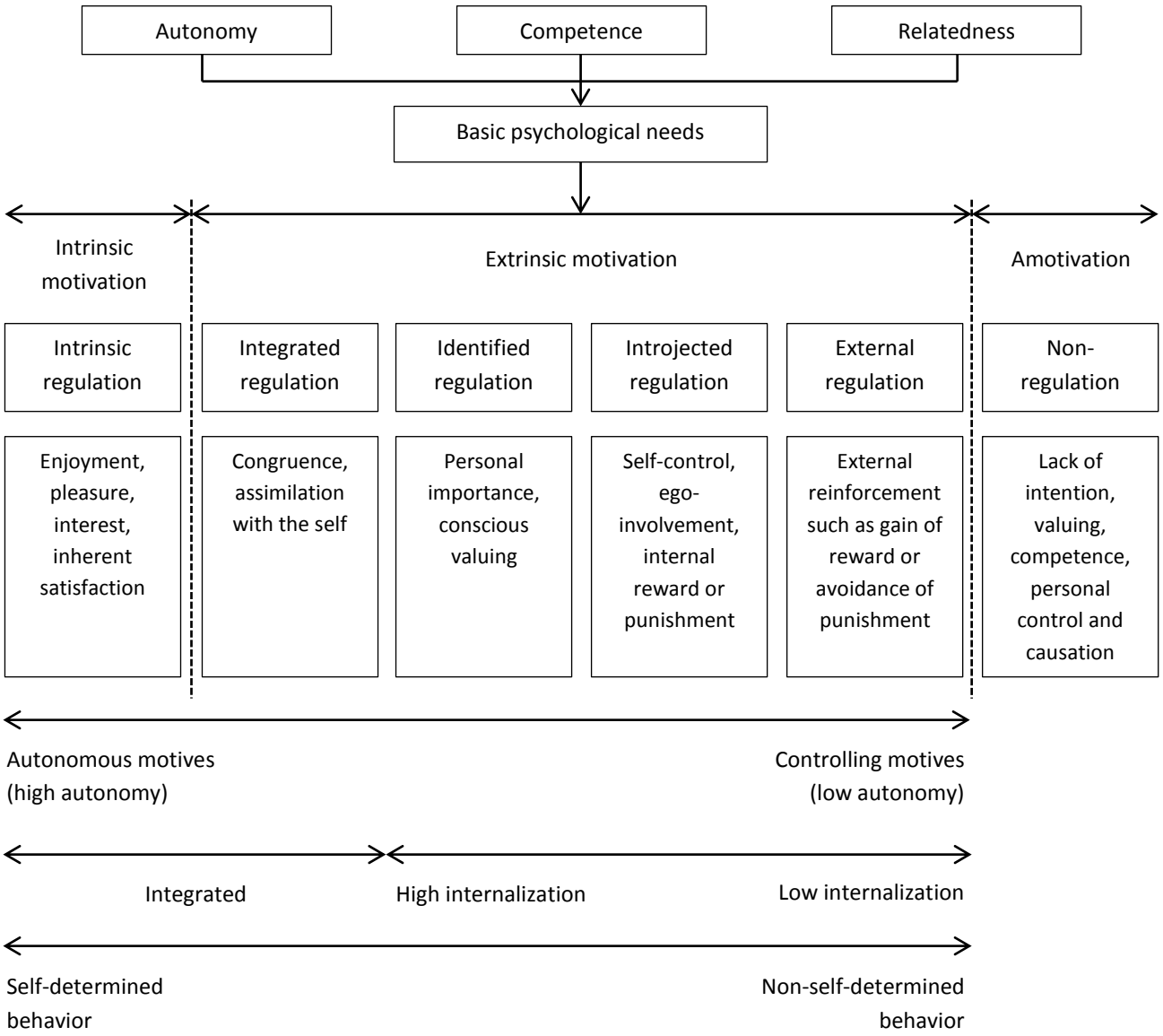

Figure 5. Schematic representation of the basic psychological needs and motivational types according to the Self-Determination Theory (Deci & Ryan, 1985).

4.4.2. Motivational continuum

The Self-Determination Theory hypothesizes that the degree to which a *social context* facilitates *individuals'* basic psychological needs influences the degree to which individuals' behavioral regulation is internalized. Moreover, the more one's motive for an action is internalized, the more he / she is assumed to be self-determined (i.e. autonomous) to adopt the particular behavior. Accordingly, perceiving satisfactory levels of autonomy, competence and relatedness can be considered as necessary for the enhancement and maintenance of self-determined and thus intrinsically motivated behavior. Whereas environmental conditions that support the basic psychological needs are assumed to facilitate intrinsic motivation, conditions that diminish feelings of autonomy, competence and relatedness are expected to undermine intrinsic forms of behavioral regulation (Ryan & Deci, 2000; Hagger & Chatzisarantis, 2007).

Intrinsically motivated behavior reflects the performance of a behavior for its inherent satisfaction and in the absence of external prompts or rewards such as winning a prize or because your partner asked you to join him / her during his / her running session (Ryan & Deci, 2000). Being intrinsically motivated entails feelings of enjoyment, excitement and personal accomplishment. Given its volitional rather than controlled character, intrinsic and thus self-determined motivation is assumed to yield greater behavioral adherence, and is therefore conceived as highly qualitative.

In addition to intrinsic motivation, the Self-Determination Theory proposes non-intrinsic types of motivation that regulate individuals' behavior (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Non-intrinsic motivation embraces two broad classes, namely amotivation and extrinsic motivation. *Amotivation* refers to the absence of intention or energy towards action. Individuals can be amotivated when they believe that the activity has no value, when they feel incompetent or because the activity does not lead to the desired outcome (Hagger & Chatzisarantis, 2007). *Extrinsic motivation* reflects the performance of a behavior in order to attain separable or external outcomes. Extrinsically motivated individuals are acting intentionally, but for instrumental reasons rather than for enjoyment. Extrinsic motivation comprises different forms, varying in terms of the degree to which the behavioral motivation is autonomous and emanates from the self (Hagger & Chatzisarantis, 2007; Ryan & Deci, 2000; Vansteenkiste et al., 2010).

The extrinsic form of motivation that is least autonomous is *external regulation*. Externally regulated behavior is performed to satisfy an external demand, to obtain a reward or to avoid punishment. Consequently, the perceived locus of causality is external. Although this form of motivation can be powerful, maintaining externally regulated behavior is difficult in that behavior controlled by external reinforcements will only persist as long as the contingencies exist. However, Ingledew and Markland (2008) designated controlled motivations as acceptable on condition that self-determined behavioral regulations are also held. An individual who is going for a walk three times a week on physician's orders can be considered as externally regulated.

A slightly more autonomous but still controlled form of extrinsic motivation is *introjected regulation*. Introjection is based on the pursuit of self-esteem and ego involvement. Rather than being controlled by external demands, individuals are controlling themselves with internal contingencies of

punishment or reward. Reasons for a behavior are thus internalized. More specifically, individuals perform a particular behavior to avoid feelings of failure, shame or guilt or to attain feelings of worth or pride. Consistent with external regulation, introjection is usually limited to produce short-term behavior given that intrapersonal control can be energy-depriving. An individual who is going for a run every day in order to avoid feeling guilty displays introjected regulation.

Identified regulation is a relatively autonomous or self-determined form of extrinsic motivation. Individuals endorse the personal value and significance of the particular behavior and perform it more willingly, even though the activity might not be perceived as enjoyable. In contrast with controlled forms of extrinsic motivation, identified regulation entails almost full internalization. Individuals who are regulated through identification do not feel pressured or controlled but are guided by the personal importance and meaningfulness of the activity or by self-endorsed commitments. An individual who is going to the gym to enhance his / her physical fitness or to meet other people demonstrates identified regulation.

The most self-determined form of extrinsic motivation is *integrated regulation*. This motivational regulation refers to the congruence of the value for the particular activity with one's other values and needs. Individuals choose to perform the behavior because it represents a harmonious part of themselves. The particular behavior is anchored within individuals' personality in that they assimilate the behavior with their overall lifestyle and goals. Even though integrated regulation is similar to intrinsic motivation, it is still considered as an extrinsic form of motivation because of the pursuit of separable outcomes rather than inherent enjoyment. An individual shows integrated regulation when he / she is participating in weekly walking sessions in a socio-cultural organization because he / she believes that this activity is consistent with other important things in his / her social life.

The different forms of motivation can be located on a *continuum*, ranging from those that are controlled (i.e. external regulation and introjected regulation) to those that are self-endorsed and personally valued, and therefore volitional and autonomous (i.e. identified regulation, integrated regulation and intrinsic motivation) (Hagger & Chatzisarantis, 2007; Ryan & Deci, 2000). The more an individual's behavioral regulation is autonomous and thus self-determined, the greater the effort and engagement he / she is likely to put in that behavior, and consequently the more the behavior is assumed to sustain in the long run (Patrick & Williams, 2012).

The continuum of the Self-Determination Theory should not be considered as a stage model, because individuals do not need to move through a process from external regulation to integrated and intrinsic forms of behavioral regulation. Instead, they can initially be situated anywhere along the motivational continuum, relying on the social conditions and the desired behavior. Irrespective of individuals' starting point, the purpose of Self-Determination Theory-based interventions is to help them to progress to a (more) autonomous form of motivation. Moreover, motivational regulations are typically assessed with respect to a particular domain or activity. Individuals can thus feel controlled for some activities and feel autonomous for other activities (Hagger & Chatzisarantis, 2007). Different forms of regulation can even coexist for the same behavior (Patrick & Williams, 2012). For example, an individual can

go to the gym on physician's orders (i.e. external regulation), but also because he / she highly values his / her health (i.e. identified regulation).

4.4.3. Empirical evidence for behavioral change

Although the Self-Determination Theory was initially developed in the context of social sciences (i.e. theory development and testing), the framework has provided empirical evidence for health behavioral changes, especially within the domain of exercise and sport (Fortier, Duda, Guerin, & Teixeira, 2012; Hagger & Chatzisarantis, 2008; Patrick & Williams, 2012; Teixeira et al., 2012). Previous research has shown that supporting individuals' basic psychological needs is effective in increasing their physical activity level. Moreover, perceived need-support is assumed to yield more autonomous forms of motivation, which in turn are assumed to result in greater persistence of physical activity behavior (Teixeira et al., 2012).

For example, Wilson et al. (2005) showed that adolescents who were involved in a four-week intervention based on the Self-Determination Theory significantly increased in moderate and strenuous intensity physical activity whereas no changes were found in a comparison group receiving general health education. Moreover, Edmunds, Ntoumanis, and Duda (2008) indicated that an autonomy-supportive, well-structured and interpersonally involving teaching style positively influenced students' behavioral, cognitive and affective responses to physical activity compared with a standard exercise class environment. Similarly, a five-week school-based intervention yielded stronger intentions and higher participation rates in (leisure-time) physical activities among pupils who were taught by autonomy-supportive teachers compared with pupils who were taught by non-autonomy-supportive teachers (Chatzisarantis & Hagger, 2009).

In addition to those positive results in a school context, the Self-Determination Theory appears to be a valuable framework to promote physical activity in a leisure or health care context. In this respect, Silva et al. (2010) demonstrated an increase in physical activity among pre-menopausal overweight women after participating in a year-round behavior change program based on the Self-Determination Theory whereas no changes were found in a control group receiving general health education. Similarly, Fortier, Sweet, O'Sullivan, and Williams (2007) concluded that patients receiving brief ánd intensive autonomy-supportive counseling showed higher levels of perceived autonomy support and autonomous motivation at six weeks and higher physical activity levels at 13 weeks compared with patients receiving only brief autonomy-supportive counseling from their health care provider.

As demonstrated above, Self-Determination Theory-grounded interventions have often focused on the satisfaction of one or two basic psychological needs, particularly on the need for autonomy and the need for competence. This is consistent with previous research on physical activity promotion in which it is suggested that supporting only one psychological need proposed by the Self-Determination Theory can be sufficient to yield positive outcomes (Dunn et al., 1998a; Stewart et al., 2001). However, this finding is in contrast with Hagger and Chatzisarantis (2008) who stated that facilitating all three needs is required to obtain optimal functioning and full internalization of behavioral processes.

In general, providing support for all three needs is assumed to produce greater behavioral engagement and persistence than supporting only one need (Edmunds, Ntoumanis, & Duda, 2006; Vansteenkiste & Sheldon, 2006). Furthermore, previous research on need-supportive coaching in a school context found that, even if teachers explicitly distinguish between providing autonomy support, competence support and relatedness support, pupils do not make a distinction between the perceptions of the different needs but rather perceive need-support in general (Haerens et al., 2013; Vansteenkiste et al., 2010). In this respect, it appears that perceiving or providing support for one of the psychological needs entails the support for the other needs as well (Vansteenkiste et al., 2010). For example, a teacher or counselor can only give informational advice (which refers to autonomy support) when he / she fully understands his / her pupil's or client's needs and perspectives (which refers to relatedness support). Giving advice would not be perceived as autonomy-supportive when there is no need to receive informational feedback.

4.4.4. Explaining behavioral change

Besides the finding that need-supportive interventions yield increased physical activity levels, the Self-Determination Theory has been considered as a valuable framework to explain motivational processes underlying exercise and sport behavior (Hagger & Chatzisarantis, 2007). A complete understanding of the motivational processes leading to sustained physical activity behavior can be beneficial to develop effective physical activity promoting strategies. Accordingly, several Self-Determination Theory-based studies have examined the mediating and predicting influences of motivational regulations and perceived need-support on behavioral changes (Fortier et al., 2012; Teixeira et al., 2012). For example, autonomous motivation and perceived competence have been shown to significantly predict physical activity among patients receiving autonomy-supportive counseling (Fortier, Sweet, O'Sullivan, & Williams, 2007). Similarly, multiple intervention studies indicated that self-determined motivation and need-satisfaction yield a positive attitude towards physical activity and are associated with increased physical activity levels (Barbeau, Sweet, & Fortier, 2003; Chatzisarantis & Hagger, 2009; Wilson, Rodgers, Blanchard, & Gessell, 2003). Furthermore, Silva et al. (2010) demonstrated a positive influence of intrinsic motivation on moderate and strenuous physical activity at 12 and 24 months among overweight women who were involved in a year-round need-supportive program. However, motivational regulations did not significantly predict mild (i.e. lifestyle) physical activity, suggesting that providing need-support is mainly effective in enhancing higher intensity physical activity behavior. This finding is consistent with Self-Determination Theory-based research of Edmunds, Ntoumanis, and Duda (2006), in which identified regulation emerged as a positive predictor of strenuous intensity physical activity in an adult population.

Moreover, Edmunds et al. (2006) proposed the identified form of behavioral regulation as especially relevant for the adoption of (strenuous) physical activity whereas they considered intrinsic motivation to be critical for behavioral persistence. According to Teixeira et al. (2012), regulation by identification with valued outcomes may even be more important than being physically active for fun,

particularly in the short run, because of the commitment and high degree of effort that are associated with regular physical activity. This suggests that the various forms of behavioral regulation contribute differently to the prediction of physical activity behavior. However, each of them is considered to be beneficial to optimal and continued physical activity engagement. Physical activity promotion should therefore facilitate different types of autonomous motivation in order to be effective (Edmunds et al., 2006; Pelletier, Fortier, Vallerand, & Briere, 2001; Teixeira et al., 2012).

The abovementioned results suggest that interventions based on the Self-Determination Theory facilitate behavior change by emphasizing the internalization of individuals' reasons for their actions. In this respect, they focus mainly on fostering the *quality* of motivation. However, it has been stated that motivation should be defined not only in terms of quality (referring to 'why') but also in terms of *quantity* (referring to 'how much') (Fortier et al., 2011). Quality of motivation reflects the different types of motivation that an individual possesses towards a task, i.e. amotivation, extrinsic motivation and intrinsic motivation. As mentioned earlier, the higher the quality of motivation, the more individuals are inclined to engage in and maintain a particular behavior. On the other hand, quantity of motivation denotes the amount of drive or desire that an individual has towards a task, and accordingly refers to the strength of motivation. Quantity of motivation aligns with concepts included in other theories on behavior change, e.g. Bandura's concept of self-efficacy (1986) and Ajzen's concept of intentions (1991). Similar to the quality of motivation, the quantity of motivation has been shown to positively influence (physical activity) behavior (Fortier et al., 2011; Hagger, Chatzisarantis, & Biddle, 2002). Both facets of motivation can thus be considered as necessary for physical activity engagement (Fortier et al., 2011; Vansteenkiste & Sheldon, 2006).

4.4.5. Motivational interviewing

Many of the need-supportive interventions have applied *motivational interviewing* as a clinical technique to facilitate the theoretically-grounded basic psychological needs, and hence to pursue self-determined forms of behavioral regulation (Patrick & Williams, 2012). Motivational interviewing has been defined as a collaborative and client-centered form of guiding to elicit and strengthen individuals' motivation for change (Miller & Rollnick, 2002). The counseling technique focuses on attaining a specific goal by exploring individuals' own reasons for change and resolving their ambivalence within an atmosphere of acceptance. Motivational interviewing has originally been based on concepts that are grounded in social-cognitive theories such as self-efficacy (Patrick & Williams, 2012). Besides supporting individuals' self-efficacy for change, the following three principles are consistent with motivational interviewing: using an empathetic interpersonal style, developing discrepancy between the present behavior and important goals and values, and rolling with individuals' resistance. These key principles have been translated into practice by communicative skills such as asking, listening and informing.

Integrating the theoretical foundations of the Self-Determination Theory with the practical guidelines according to motivational interviewing might contribute to the field of behavior change (Patrick

& Williams, 2012; Vansteenkiste & Sheldon, 2006). In this respect, research has pointed out a conceptual overlap between the Self-Determination Theory and motivational interviewing (Patrick & Williams, 2012). In particular, and as stated by Vansteenkiste and Sheldon (2006), the theoretical focus on providing need-support and on internalizing motives for action can be considered as complementary with the clinical guidelines proposed by motivational interviewing because of three reasons:

(1) Both frameworks have the same basic assumption, i.e. individuals are naturally oriented towards growth, health and well-being. Accordingly, they both emphasize the importance of supporting self-initiated thoughts about behavioral change and avoiding external control or pressure;

(2) Motivational interviewing promotes by definition intrinsic motivation, i.e. performing an activity for its own sake. However, the Self-Determination Theory provides a conceptual refinement of behavioral regulation. More specifically, according to the Self-Determination Theory, individuals will probably change their behavior because of instrumental reasons or to achieve a highly valued intrinsic outcome (i.e. identified or integrated regulation) rather than because the activity is inherently enjoyable. In this respect, motivational interviewing may benefit from the Self-Determination Theory-based distinction between different types of motivation. Moreover, the Self-Determination Theory might be helpful to understand why motivational interviewing works. More specifically, given that applying the four abovementioned key principles of motivational interviewing yields positive outcomes through the satisfaction of the basic psychological needs, the Self-Determination Theory provides a theoretically-grounded explanation for the underlying mechanisms of motivational interviewing;

(3) Motivational interviewing can provide concrete motivational factors that are related to the Self-Determination Theory's concept of autonomy support and that can promote or impede internalization of change. The following examples are techniques that stem from motivational interviewing and that can facilitate the processes of change: formulating an agreement between client and counselor, asking open-ended questions, summarizing and reflective listening (which raises individuals' awareness and helps them to choose autonomously).

4.4.6. Need-support and well-being

Self-determined forms of motivation and perceived need-support have not only been shown to be related to behavioral engagement but also to individuals' functioning, health, growth, social development and well-being across their lifespan (Ryan & Deci, 2000; Ryan & Deci, 2002; Ryan, La Guardia, Solky-Butzel, Chirkov, & Kim, 2005; Teixeira et al., 2012; Vansteenkiste et al., 2010; Wilson & Rodgers, 2007). More specifically, individuals who experience support for autonomy, competence and relatedness have higher levels of vitality, self-esteem, energy, mental health and positive affection (Deci & Vansteenkiste, 2004; Hagger & Chatzisarantis, 2007). By contrast, social environments that fail to provide support for the basic

psychological needs, that engender conflicts between the needs or that involve an imbalance in need-satisfaction across contexts contribute to alienation, distress and ill-being (Milyavskaya et al., 2009; Ryan & Deci, 2000; Vansteenkiste et al., 2010).

The positive influence of perceived need-support on well-being is presumed to be universal, and thus valid across time, populations and cultures. However, the degree to which need-support improves health and well-being varies *between* individuals in that it depends on the attainment of one's personal goals. More specifically, need-satisfaction will only enhance well-being within a context that is central to one's life such as work or leisure time (Ryan & Deci, 2000). Moreover, an individual's level of well-being is assumed to enhance to a larger extent when he / she pursues intrinsic goals such as affiliation instead of extrinsic goals such as image or wealth (Vansteenkiste et al., 2010). In addition to the variation of well-being between individuals (i.e. according to the degree of perceived need-support), the level of well-being can fluctuate *within* an individual (i.e. according to the degree to which one feels more autonomous, competent and related to others during his / her daily activities). In this respect, previous research highlighted the daily variability in emotions (e.g., mood, vitality, self-esteem) as a result of the daily fluctuations in basic need-satisfaction (Reis, Sheldon, Gable, Roscoe, & Ryan, 2000; Sheldon, Reis, & Ryan, 1996).

4.5. Choosing a theoretical framework

Each of the abovementioned social and behavioral theories has been shown to be valuable in the promotion of physical activity among different population groups. Nevertheless, the following five reasons have led us to apply the Self-Determination Theory (Deci & Ryan, 1985) as an underlying framework of the physical activity interventions included in this doctoral thesis:

(1) The Self-Determination Theory can be considered as a framework *covering constructs that are included in other theories on behavior change*. For example, the need for competence can be considered as similar with Bandura's (1986) concept of perceived self-efficacy (i.e. individuals' judgment on how well they can perform an activity required to deal with a prospective situation) and with Ajzen's (1991) concept of perceived behavioral control (i.e. individuals' perception of their ability to perform a given behavior). Each of the psychosocial models postulates thus that individuals' behavior is strongly influenced by their confidence in their ability to perform the particular behavior successfully, but they propose this concept under a different name (Ajzen, 1991; Bandura, 2004). Also the Self-Determination Theory's need for relatedness does to a certain degree overlap with indicators (of outcome expectations) that are relied to other theoretical frameworks, e.g. subjective norms as an antecedent of intention according to the Theory of Planned Behavior (Ajzen, 1991). However, given that subjective norms refer to the perceived social pressure by significant others, the need for relatedness might contribute to behavioral change in a more positive way, e.g. by creating a meaningful relationship within an atmosphere of acceptance. Contrary to other behavioral theories, the

Self-Determination Theory has also postulated the need for autonomy as crucial for intrinsic motivation to thrive (Hagger & Chatzisarantis, 2007);

(2) Interventions based on the Self-Determination Theory aim at enhancing autonomous types of motivation such as identified regulation. Because of the voluntary character of autonomously motivated behavior, Self-Determination Theory-grounded interventions are hypothesized to facilitate *long-term engagement in physical activity*. However, despite the assumption on the persistence of behavior changes, most previous research on need-supportive physical activity counseling has been cross-sectional. Moreover, the studies that have applied a longitudinal design have been inconclusive on the longer-term effects, i.e. six months or more after the intervention (Teixeira et al., 2012). In this thesis manuscript, we have especially focused on the maintenance of the effects of different Self-Determination Theory-based physical activity promoting strategies;

(3) Given that ageing may involve feelings of reduced personal control and competence, the Self-Determination Theory seems a particularly relevant and applicable framework to the *older population* (Dacey, Baltzell, & zaichkowsky, 2008; Jette et al., 1998). However, the majority of studies on need-supportive physical activity counseling have focused on younger and adult populations (Dacey, 2005; Texeira et al., 2012). By approaching the older adult population in two of the three Self-Determination Theory-based interventions included in this thesis, we have attempted to fill this gap in the literature;

(4) The determinants of physical activity behavior postulated by the Self-Determination Theory are consistent with the frequently reported physical activity barriers among the (older) adult population. More specifically, and as described in section 2.4.5., a lack of motivation, perceiving physical activity as a less important aspect of one's life and feelings of insufficient competence have been found to be the most frequently reported reasons why people fail to participate in physical activity. On the other hand, the most frequently reported reasons for engagement in physical activity are related to self-determined types of motivation. For example, fitness enhancement, health improvements and appearance refer to identified forms of behavioral regulation whereas enjoyment refers to intrinsic motivation;

(5) The Self-Determination Theory has been considered as a suitable and applicable framework for *health promotion and behavior change at community level*, e.g. sport and exercise engagement, healthy nutrition, weight management and smoking cessation. Specifically, according to this theory, influencing social environments can affect individuals' perceptions of autonomy, competence and relatedness. A social context can thus facilitate or undermine individuals' self-determined motivation as a function of the degree to which the context supports or thwarts the satisfaction of the basic psychological needs (Hagger & Chatzisarantis, 2007). Given that the Self-Determination Theory is highly consistent with clinical guidelines and tenets of practice (e.g., motivational interviewing), this framework seems to be suitable

not only for scientific research but also for practical discourses (Patrick & Williams, 2012). Because the outline of this thesis was not only to provide scientific evidence but also to test the value of the Self-Determination Theory in applied settings and to explore opportunities to translate research into the wider community, we considered the Self-Determination Theory as an appropriate framework for the physical activity interventions described in this thesis.

4.6. Social Identity Approach

Despite the well-established usefulness of the Self-Determination Theory within the domain of public health promotion, the subsequent two reflections with respect to need-supportive physical activity interventions might explain the rather *inconclusive results on sustained behavioral engagement* within the current literature.

First, crucial within the Self-Determination Theory is the facilitation of autonomous types of motivation, meaning that individuals engage in an activity because the activity will help them to attain valued goals, because of the personal importance and meaningfulness associated with the activity, because the activity fits their personality and overall lifestyle or for reasons of interest, enjoyment or challenge rather than under control of external or internal incentives. Although more autonomous forms of motivation are hypothesized to yield greater behavioral persistence, intervention strategies based on the Self-Determination Theory have mainly focused on facilitating *identified regulation*, which is the least self-determined type among the autonomous forms of behavioral regulation. For example, health counselors encourage individuals to increase their physical activity level in order to attain improved physical fitness. By contrast, encouraging individuals to perform a behavior because of the assimilation with their overall lifestyle or for their own sake, challenge or enjoyment (which refers to more autonomous forms of motivation) has usually not been the initial purpose of health programs.

Second, even though it is stated that the support for relatedness does not need to be as proximal as the support for autonomy and competence, the Self-Determination Theory postulates that feeling a sense of connectedness is essential to enhance self-determined types of motivation (Hagger & Chatzisarantis, 2007). Nevertheless, intervention strategies based on the Self-Determination Theory have mainly focused on supporting the need for autonomy and the need for competence, e.g. by providing personal control and optimal challenge, respectively. By contrast, the *need for relatedness* has been approached to a lesser extent within need-supportive physical activity promotion. Moreover, interventions that did aim to foster the need for relatedness have mainly emphasized its interpersonal component, e.g. by creating a meaningful relationship between counselor / teacher and client / pupil. Whereas most psychological theories emphasize the interpersonal character of interaction, social psychological theories underscore the importance to define one's sense of self not just in personal terms but also in social terms (Oakes & Turner, 1990; Jetten, Haslam, & Haslam, 2011). In this respect, in the Social Identity Approach, which embraces the Social Identity Theory (Tajfel & Turner, 1979, 1986) and the Self-Categorization Theory (Turner, 1985; Turner, Hogg, Oakes, Reicher, & Wetherell, 1987), relatedness at the *intergroup level* is

proposed as a crucial antecedent for behavioral change, and in particular health behavior. Moreover, group membership and being embedded in a social network are assumed to produce a positive impact not only on behavioral changes but also on health and well-being.

As suggested above, the inconsistent results of Self-Determination Theory-based counseling upon the maintenance of physical activity may have been caused by the following two reasons: (1) Most of the need-supportive physical activity interventions did not facilitate the most self-determined forms of motivation; and (2) Most of the need-supportive physical activity interventions did approach individuals' need for relatedness only at the interpersonal level. The Self-Categorization Theory might provide an answer to these two considerations, and might therefore be a more effective framework than the Self-Determination Theory for the promotion of physical activity, especially in the long term. Specifically, Self-Categorization Theory-based counseling is assumed to target individuals' relatedness at the group level (i.e. through identification with a particular social group), and accordingly to facilitate their physical activity engagement because of the assimilation of this behavior with their identity (i.e. through integrated regulation). In this respect, in Chapter 4.1, we did integrate the Self-Determination Theory and the Self-Categorization Theory with respect to the development and implementation of a physical activity counseling strategy among older adults.

4.6.1. Social Identity Theory

The Social Identity Theory is a social psychological framework that describes the cognitive and motivational basis of intergroup differentiation as well as the role of the self in intergroup relations (Haslam, 2004; Hogg, 2006; Strycker, 1987). The theory postulates that individuals define their sense of self not just in personal terms but also in terms of their group membership (Terry & Hogg, 1996). More specifically, according to the Social Identity Theory, individuals categorize and perceive themselves as belonging to various social groups such as triathletes, students or mothers (Trepte, 2006). This categorization process improves individuals' understanding of the world because it allows them to order the social environment and to structure social interactions. Moreover, the relational structuring helps individuals to find their place in the society and to better understand who they are (Haslam, Jetten, Postmes, & Haslam, 2009; Tajfel, 1979).

4.6.1.1. Interpersonal-intergroup continuum

With respect to individuals' tendency to categorize themselves, the Social Identity Theory proposes a bipolar continuum ranging from the interpersonal pole at which individuals define their sense of self at the personal level to the intergroup pole at which individuals define their sense of self at the group (i.e. social) level (Figure 6). Given that most social situations involve elements of both the personal and social identity, the interpersonal-intergroup distinction can be considered as a continuum rather than a dichotomy (Brown, 2000). The exact place on the continuum at which individuals locate their sense of self can vary according to the particular context (i.e. contextuality; see section 4.6.1.2.) and might affect

individuals' cognitions and behavior (Haslam, 2004; Tajfel & Turner, 1979; Terry, Hogg, & White, 1999; Terry & Hogg, 1996).

At the one extreme of the continuum, individuals' feelings and actions are influenced merely by their personal characteristics and motivations (i.e. *personal identity*). Accordingly, individuals understand themselves in terms of unique attributes that are not shared with others. In this respect, they compare 'you' with 'I' and 'me'. Because every interaction will at least partially be affected by individuals' assignment to one or more social groups, Tajfel and Turner (1986) considered the personal identity extreme as redundant.

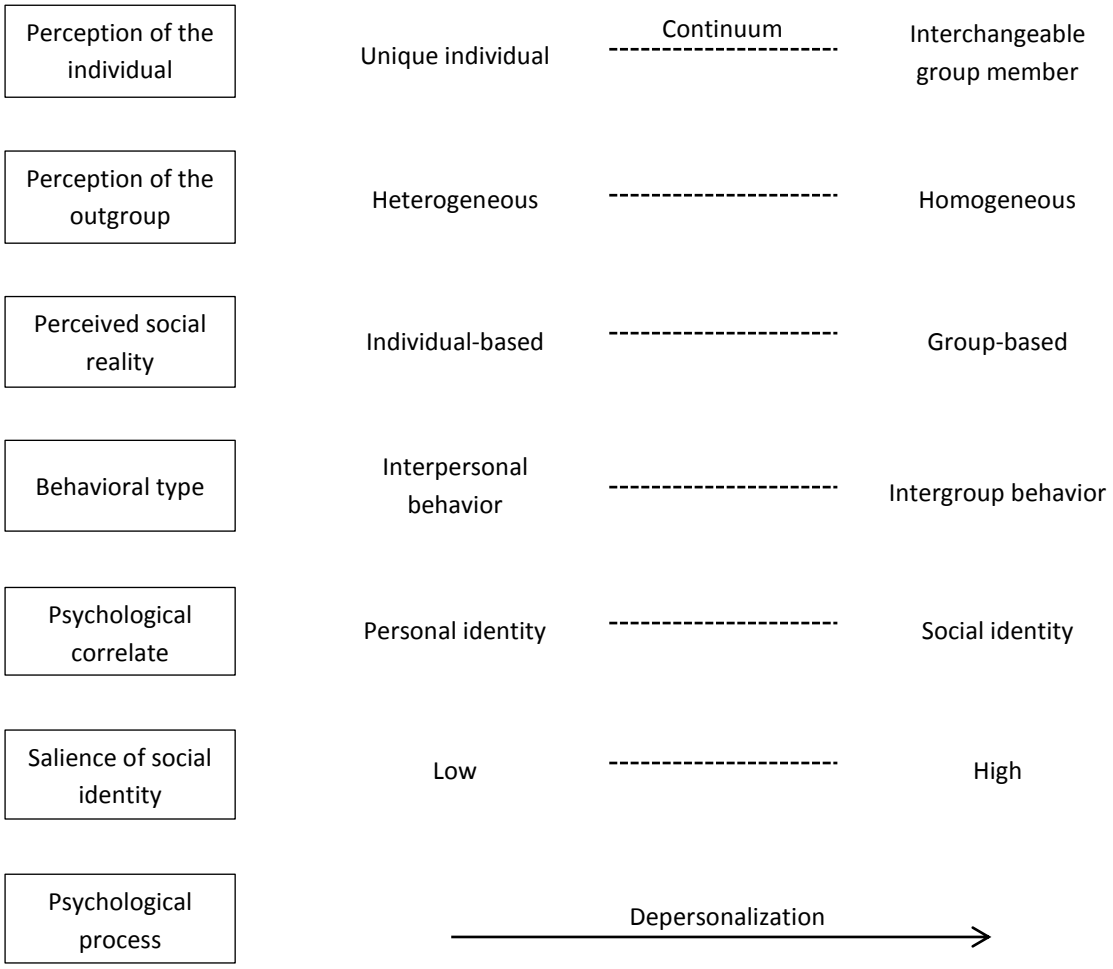

Figure 6. Continua representing the variation in individuals' level of identification consistent with the Social Identity Theory (Tajfel & Turner, 1979) and in individuals' self-categorization consistent with the Self-Categorization Theory (Turner, 1985).

At the other extreme, individuals' feelings and actions are determined solely by group-related characteristics and their group membership (i.e. *social identity*). This means that individuals define and evaluate themselves in the same way as other members of this (in-) group. Moreover, they relate in an identical manner to individuals who are not a member of the ingroup. 'Them' is thus compared with 'we' and 'us' (e.g., students versus professors, athletes versus physically inactive people) (Hogg, 2006). It should be noted that interaction between members is not a precondition for the perception to belong to a particular group. For example, an individual who is playing with his / her grandchild can define him / herself in terms of an older person, even though he / she is not in the company of other older adults. A person alone can feel and act as a group member as long as he / she shares a social identity that is defined by a larger group (Hogg, 2006; Trepte, 2006). From the moment that individuals have a sense of belonging and identify, define and evaluate themselves in terms of properties of a group, they can think, feel and behave as group members. In this respect, Hogg (2006) stated that the essence of group membership is identification, whether the group formation emanates from formal and impersonal characteristics (e.g., ethnicity or social roles such as partner) or is based on close interpersonal bounds and personality characteristics (e.g., fans of a football club or socially engaged persons). However, according to Terry, Hogg, and White (1999), the Social Identity Theory especially focuses on identities that are derived from personality-based membership rather than role-based membership. Moreover, according to Thoits and Virshup (1997), a perception of similarities in beliefs and behaviors may be a stronger basis of collective identification than role-based similarities.

4.6.1.2. Social identification

As indicated above, a group is more than an external feature that structures and organizes the world. It is a cognitive set of three or more individuals who consider themselves as members of the same social category (e.g., grandparents, socially engaged persons, athletes) and accordingly hold a common social identification (Hogg, 2006; Stets & Burke, 2000; Tajfel & Turner, 1979; Turner, 1982). Individuals sharing the same *social identity* evaluate themselves in terms of shared attributions that distinguish them as a group from other people. Tajfel (1978) defined a social identity as 'the part of individuals' self-concept that stems from their knowledge of their membership of a social group together with the emotional and value significance to them of that membership'.

Social identities are cognitively represented as *group prototypes*, i.e. a subjective set of attributes (beliefs, perceptions, attitudes, feelings and behaviors) that are related to each other in a meaningful way (Haslam, 2004; Terry et al., 1999). This set of attributes strikes a balance to minimize ingroup differences and maximize intergroup differences. The prototype of a group is assumed to be descriptive (i.e. defining the characteristics that should be presented by all group members), prescriptive (i.e. indicating how group members should behave and which norms should be taken into account), emotional (i.e. associating positive or negative emotions with the group membership) and evaluative (i.e. distinguishing the group

positively or negatively compared to other groups) (Hornsey, 2008; Stets & Burke, 2000; Tajfel, 1979; Vanbeselaere, 2000).

Individuals who strongly identify with a group will assimilate themselves with the group prototype, and accordingly will tend to adopt the *norms* and values that are associated with this prototype (Brown, 2000; Chatzisarantis, Hagger, Wang, & ThØgersen-Ntoumani, 2009). Group norms can be defined as subjective goals, perceptions, beliefs, attitudes and behaviors of a relevant group that are considered to be normative for and acceptable by ingroup members. Moreover, norms refer to certain rules for how group members should behave. They are thus the basis for *mutual expectations and social influence* among group members (Brown, 2000; Jetten et al., 2011; Sassenberg, Matschke, & Scholl, 2011; Turner, 1991). More specifically, individuals who share a sense of identification with other group members are motivated to reach agreement with them and to harmonize their behavior with perceived norms, values and activities that are relevant to that identity. For example, an individual who categorizes him / herself with Frisians will probably participate in the 'Elfstedentocht', an individual who categorizes him / herself with Flandriens will probably engage in cycling, an individual who defines him / herself as a fan of Anderlecht will probably wear something purple when he / she attends a competition, an individual who categorizes him / herself as a socially engaged person will probably be socially committed, involved in volunteering or social work and worried about others' health and well-being, an athletic person who identifies himself with professional cyclists will probably shave his legs, an individual who categorizes him / herself as an older person will probably make use of the elevator instead of climbing the stairs etc. Given that group formation influences individuals' perceptions, attitudes and behavior, a group can be considered as more than the sum of its parts. The more individuals define themselves in terms of group membership and identify themselves with a social group, the more they will perform the normative behavior instead of behaving in accordance with their own personal characteristics (Haslam et al., 2009; Hogg, 2006; Terry et al., 1999). Tarrant, Hagger, and Farrow (2011) described the relationship between individuals' identification and behavior in terms of health behavior. More specifically, they elaborated on the influence of individuals' social identification on their orientations and decisions towards health (Figure 7).

Social norms can influence individuals' behavior in an informational way or in a normative way. However, whether the influence is informational or normative, subjective norms can only affect individuals' behavior when they emanate from a behaviorally relevant reference group at the particular time (Terry & Hogg, 1996). *Informational influence* is based on accurate and valid perceptions, attitudes and beliefs. Moreover, individuals accept, agree with and internalize information from other group members because the information disambiguates reality (Abrams & Hogg, 1990; Terry & Hogg, 1996). For example, during one's first day at school or at work, an individual will probably imitate the other students or colleagues because he / she believes their behavior provides information about reality. By contrast, *normative influence* is based on individuals' need for approval and acceptance. It refers to subjectively experienced pressure to comply with the group. For example, a student who is a member of a students' union will probably be present at the weekly carousal in order to harmonize his / her behavior with the perceived

norms associated with this group membership and to be accepted by the group. The normative influence as a determinant of individuals' behavior can be considered as similar to the outcome expectations of Bandura's Social-Cognitive Theory (2004) and the subjective norms of Ajzen's Theory of Planned Behavior (1991) in that it refers to the perceived social pressure (not) to engage in a particular behavior. However, normative influence as described by the Social Identity Theory occurs at the social level (i.e. at the level of group membership) whereas the perceived influence as described by the Social-Cognitive Theory and the Theory of Planned Behavior can also take place at the interpersonal level (i.e. by significant others such as one's partner).

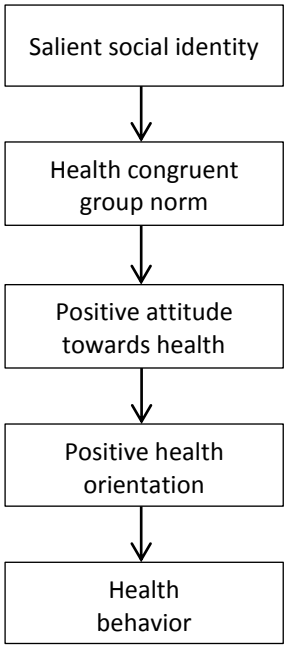

Figure 7. Identity Salience Model, representing the relationship between social identification and health (Tarrant, Hagger, & Farrow, 2011).

The more individuals define their sense of self at the social level and thus behave in accordance with the perceived norms of the group prototype, the more *depersonalization* comes into play (Haslam, 2004; Turner et al., 1987). This cognitive process refers to an individual's evaluation of him / herself as an embodiment of the ingroup prototype and as a representation of the social category including the meanings and norms related to that category (Stets & Burke, 2000). Moreover, individuals see themselves and other group members as interchangeable models of the group prototype rather than as unique persons. Accordingly, by defining their sense of self in intergroup terms, individuals tend to perceive the ingroup (and also the outgroup) as a homogeneous and undifferentiated category (e.g., fans of a particular football club during a competition). Members of the same group will act and react uniformly, i.e. in accordance with the perceived norms that are associated with the group prototype (Hornsey, 2008; Tajfel, 1978). On the other hand, when an individual defines him / her sense of self in personal terms, the personal factors will have the strongest impact on the individual's feelings and behavior (Terry & Hogg, 1996).

Each individual has multiple personal and social identities, depending on the number of personal relationships that he / she is involved in and the number of groups that he / she belongs to. However, only one identity can be activated in any given situation (Hogg, 2006; Stets & Burke, 2000). The place at which the individual locates him / herself at the continuum, the way in which the individual categorizes him / herself and the (level of) identity that is activated are determined by social and psychological factors in the given situation (Haslam, 2004). More specifically, individuals identify themselves with the (social) identity or group that is perceived as most relevant, important and meaningful in the particular context (i.e. *contextuality*) (Hogg, 2006; Jetten et al., 2011). Moreover, according to Brown (2000), the social category that is most likely to be activated in a given situation is the category that is cognitively the most *accessible* to the individual (i.e. the category that is primed by the situation) and that best *fits* the situation he / she is faced with (i.e. the category that is perceived to best reflect social reality). Social identification is thus *dynamic* in that it can change over time and fluctuate according to the context. For example, an American soldier probably identifies himself with other husbands and fathers when he leaves his family for a couple of months whereas he might identify himself with other Americans when he sees the American flag flapping on the Iraqi territory. Similarly, an individual probably identifies him / herself with older persons or grandparents when he / she accompanies his / her grandchild to school whereas he / she might identify him / herself with physically active individuals when he / she is participating in a twenty-kilometer cycling tour.

The activation of a particular (social) identity in a given situation can be defined as *salience*. A salient social identity is thus one that is functioning psychologically to increase the influence of one's group membership on his / her perception and behavior (Oakes, 1987). On the other hand, when an individual's identity as a unique person is salient, personal beliefs, attitudes and feelings are likely to form the most accessible basis for behavioral choice (Terry & Hogg, 1996).

4.6.1.3. Individuals' evaluation of group membership

When a particular situation leads individuals to identify themselves with a social group and to evaluate their sense of self in terms of their group membership, there are two processes that come into play, i.e. categorization and self-enhancement (Haslam, 2004; Terry & Hogg, 1996; Terry et al., 1999). The *categorization* process involves the accentuation of similarities between members of the same (in-) group and differences between the in- and outgroup on stereotypical dimensions. When a category distinction maximizes ingroup similarities and intergroup differences, a high level of (comparative) fit may be perceived (Brown, 2000; Hornsey, 2008). As indicated above, individuals are inclined to categorize themselves in a way that they perceive the highest level of fit in any given situation.

Self-enhancement reflects the perceptually and behaviorally favoring of the ingroup over the outgroup. More specifically, individuals strive to achieve a positive self-esteem by positively differentiating their ingroup from an outgroup on a valued dimension. Defining one's sense of self in terms of group membership can thus be used to feel good. For example, an individual who is engaged in running every week probably identifies him / herself with athletic or physically active persons. Given that the physical

activity identity is a positively valued identity, this group membership will yield a positive self-esteem among the individual. Similarly, the warm personality that is inherent to socially engaged persons will probably produce positive feelings among individuals who define themselves in terms of that group membership at a particular moment. The more a comparison (out-) group is similar to one's own (in-) group, the more social comparison becomes relevant and the more a positive outcome will improve individuals' self-esteem. Besides the social category with which the ingroup is compared, the dimension on which groups are compared can influence one's feelings of self-worth. In this respect, individuals will select dimensions to compare the in- and outgroup in a way that social comparison will yield self-enhancing outcomes (Abrahams & Hogg, 2006; Stets & Burke, 2000).

The finding that categorization makes individuals discriminate against outgroups and favor their ingroup is consistent with the conclusions on *minimal group experiments*, from which the Social Identity Theory originates (Trepte, 2006). In these minimal group experiments, people were randomly assigned to one of two previously meaningless groups (e.g., based on the estimated number of dots on a screen, on individuals' preferred color, on individuals' preference of the painters Klee or Kadinsky). Subsequently, they were asked to allocate points to members of their ingroup and members of the outgroup (Tajfel, Billig, Bundy, & Flament, 1971; Tajfel & Turner, 1979). These experiments demonstrated that merely categorizing oneself as a group member is sufficient to lead an individual to display ingroup favoritism. Not doing well as such but doing better than the other group appeared to be essential to improve one's self-esteem (Haslam, 2004).

In addition to consciously select the comparison group and dimension, individuals often employ *belief structures* in order to develop a positive social identity and accordingly attain self-enhancement and a positive self-esteem. Tajfel & Turner (1979) distinguished three strategies to obtain self-enhancement: individual mobility, social creativity and social competition. *Individual mobility* is most likely to be pursued when the social group with which the individual categorizes him / herself has a relatively low status and when group boundaries are perceived as permeable. In this respect, individualized behavior (i.e. moving to a higher-status group) is believed to be the best strategy for advancement rather than engaging in a collective action designed to improve the group's status in general (Haslam, 2004). By contrast, social creativity and social competition are assumed to be aspects of the *social change* belief structure, which refers to intergroup behavior or a group action. Individuals are motivated to achieve social change when they perceive group boundaries as relatively impermeable and believe that moving to another group will not yield self-enhancement. In this respect, group behavior (i.e. improving the negative or maintaining the positive conditions of one's ingroup) rather than individualized behavior is believed to be most effective to enhance individuals' self-esteem. For example, individuals who categorize themselves to a low-status group may be inclined to apply *social creativity*, meaning that they compare the in- and outgroup on other dimensions or redefine the value that is assigned to the ingroup characteristics. For example, older adults who are suffering from health conditions may increase their self-esteem by acknowledging their reduced competence and at the same time accentuating their warm and empathetic personality (compared with

more competent but probably cold members of the outgroups). *Social competition* might be operated when individuals perceive the status of the ingroup as unfair and aim to confront the outgroup with their circumstances. Social competition represents a more overt attempt to challenge the ingroup status, and hence to improve individuals' self-esteem (Haslam, 2004; Trepte, 2006).

As indicated above, individuals tend to positively distinct the social category with which they identify themselves from other categories due to the influence of the status of the ingroup on their own self-esteem and self-worth. The extent to which ingroup favoritism emerges is determined by the following three factors: (1) the extent to which the individuals identify themselves with the particular group, (2) the extent to which the context provides ground for the comparison between groups, and (3) the perceived relevance of the outgroup (Haslam, 2004). More specifically, the more an individual identifies him / herself with a particular ingroup, the more the context provides ground for comparison between groups and the more he / she perceives the outgroup as relevant, the more ingroup favoritism is likely to emerge. For example, ingroup favoritism will probably emerge in a work-related context in which men and women are talking about (the inequality of) their salary.

4.6.2. Self-Categorization Theory

The Self-Categorization Theory (Turner, 1985) is an extension of the Social Identity Theory (Tajfel & Turner, 1979) and is developed to explain behavior in terms of individuals' cognitive process of *self-categorization* (Abrams & Hogg, 1990). More specifically, the Self-Categorization Theory describes the cognitive processes associated with individuals' moving along Tajfel's interpersonal-intergroup continuum (1979) and how personal and social identities are made salient. In this respect, cognitive representations of the self take the form of self-categorizations (Haslam, 2004). The self is thus believed as a member of a category, which is similar to other members of that category and distinct from members of other categories.

Both the Social Identity Theory and the Self-Categorization Theory share the idea of *social identification*. However, according to the Self-Categorization Theory, the social identity is considered as the process that changes interpersonal behavior to intergroup behavior (Trepte, 2006; Turner, 1985). More specifically, whereas the Social Identity Theory assumes that an individual can define his / her sense of self on a bipolar continuum ranging from a personal to a social identity or from interpersonal to intergroup behavior, the Self-Categorization Theory assumes that there are three levels at which an individual can define him / herself: the subordinate level, the intermediate level and the superordinate level. It is hypothesized that when one level of self-definition becomes salient, the other levels become less salient (Turner, 1985). At the subordinate level, individuals categorize themselves as individuals compared to other individuals and in terms of their *personal identity*. At the intermediate level, individuals categorize themselves as members of a (in-) group compared to relevant outgroups and in terms of their *social identity*. Given the large variety with respect to group formation, the intermediate level consists of different sublevels. For example, an individual can categorize him / herself as a scientist, a psychologist or a social

psychologist, an individual can categorize him / herself as an athlete, a track and field athlete or a short distance runner etc. At the superordinate level, individuals categorize themselves as human beings compared to other species and in terms of their *human identity*.

Individuals will respond and behave differently, depending on whether they define themselves as unique persons, as group members or as humans (Hornsey, 2008; Jetten et al., 2011). As mentioned above, the formation and salience of a social category is determined by the perceived intra- and intercategory differences (i.e. *comparative fit*). More specifically, in a given *context*, individuals are likely to use a particular social self-category in order to make the differences within the category smaller than between the self-category and other categories. Besides the influence of the 'on the spot judgment of relative differences', the social category with which individuals identify themselves is affected by the extent to which individuals perceive themselves as representative or prototypical for the category (Haslam, 2004). For example, an individual who is running once in a month will be less likely to define him / herself in terms of an athletic person than an individual who is running five times a week.

Similar to the Social Identity Theory, changes in self-categorization are associated with changes in individuals' perceptions and behavior (Haslam, 2004). More specifically, according to the salience of the different levels of an individual's self-categorization, he / she will be likely to express more individual differences or more collective similarities (Turner, 1985). In this respect, an individual is defined and will act in terms of personal characteristics whereas a group member is defined and will act stereotypically in terms of shared characteristics, values, goals and norms of individuals who are perceived as representative of the same social category. When category distinctions are salient, individuals perceptually enhance similarities within the group and enhance differences between groups (Hornsey, 2008). Categorization does not only influence the way individuals see themselves but also changes the way individuals see others. For example, a male student and a female student who are engaged in breakdance and ballet, respectively, can describe and see each other in different ways, depending on the context and their categorization, e.g. they can define each other in terms of their personal characteristics when they are at home (e.g., kind, funny, helpful), in terms of the norms and values that are associated with their group membership of 'breakdancers' (e.g., muscular, expressive, nonchalant) and 'ballet dancers' (e.g., elegant, flexible, thin) when they are at a dance contest, in terms of their categorization as a student (e.g., focused, strong, reflective) when they are in an examination period etc.

4.6.3. Empirical evidence for the Social Identity Theory

4.6.3.1. Interventions affecting individuals' behavior

Social identification, social categorization and group norms have been shown to provide a basis for individuals' behavior in a wide range of contexts (Abrams & Hogg, 1990). For example, Terry et al. (1999) demonstrated that the perceived norms of a behaviorally relevant reference group were related to individuals' intention to engage in household recycling. However, the relationship emerged only among individuals who identified themselves strongly with the group. Within the physical activity context, Renger,

Steinfelt, and Lazarus (2002) showed that a media campaign in which local community members promoted pro-physical activity norms directly affected the physical activity behavior of the townspeople. Similarly, previous research has demonstrated that the perceived normative support of a relevant reference group (e.g., student identity) influenced individuals' intentions to engage as well as their engagement in different health behaviors such as sun protection and regular physical activity (Chatzisarantis et al., 2009; de Bruijn & van den Putte, 2012; Hamilton & White, 2008; Jackson, Smith, & Conner, 2003; Strachan, Brawley, Spink, & Glazebrook, 2010; Terry & Hogg, 1996). Consistent with Terry et al. (1999), group norms affected behavior (intention) only among those who identified strongly with the reference group (e.g., student identity) whereas perceived behavioral control (i.e. a personal factor) was found to be the strongest predictor of intentions among low identifiers.

The abovementioned studies provide empirical evidence for the role of social identification as an additional determinant of intention and behavior, as displayed by Ajzen's Theory of Planned Behavior (1991). More specifically, associating positive descriptive norms with a relevant reference group, and thus at the social level of the self, has been shown to facilitate behavior change. Accordingly, an extension of the Theory of Planned Behavior could be valuable within the context of health promotion. Nevertheless, to our knowledge, no studies have evaluated the effectiveness of integrating the Self-Determination Theory with the Social Identity or Self-Categorization Theory, even though both frameworks have been shown to be effective in (health) behavior change. Moreover, given that the Self-Categorization Theory assumes different levels of self-categorization, this theory can be considered as *complementary* to the Self-Determination Theory. On the one hand, Self-Determination Theory-based interventions focus on fulfilling the need for relatedness particularly at the personal level, e.g. by creating a comfortable relationship between coach and client. By supporting the basic psychological needs at the personal level of the self and by approaching individuals' uniqueness and personal characteristics, the individuals' personal identity (compared to other individuals' personal identity) becomes salient rather than their social identity. On the other hand, Social Identity Theory-based studies emphasize individuals' identification at the intermediate level, i.e. in terms of their membership of a particular group compared to relevant outgroups. This level of identification embraces descriptive and prescriptive normative information with respect to the group to which they belong. Given that the way individuals behave is influenced by their level of self-categorization, integrating the Self-Determination Theory and Self-Categorization Theory could contribute to health behavior changes (see Chapter 4.1).

4.6.3.2. Health and well-being

Besides the effects of categorization on individuals' behavior, group membership has also been shown to affect individuals' cognitive function (Haslam et al., 2009). More specifically, if individuals categorize themselves with a group that provides stability, meaning, purpose and direction, group membership will positively influence their mental health. In this respect, social identification is essential to individuals' health and well-being in that it can enhance their self-esteem and self-worth and it can help

them to cope with negative consequences. By contrast, individuals' well-being will be treated when the ingroup is inferior to the comparison group. Haslam, Jetten, Postmes, and Haslam (2009) described five associations of social identification with health and well-being:

(1) A social identity has been demonstrated to be a determinant of *symptom appraisal and response*. For example, asthma patients have been shown to be more likely to take their medication when they perceive themselves as belonging to the group of asthma sufferers than when they do not;

(2) Social identification has been recognized as a contributor to *health-related behavior* in that norms associated with salient identities can yield health promoting or health impeding behavior. In this respect, Laverie (1998) showed that individuals were motivated to participate in aerobic classes because of their identification with the sport and fitness group. By contrast, Oyserman, Fryberg, and Yoder (2007) demonstrated that members of ethnic minority groups reacted against messages on healthy diet from White middle-class populations because they considered healthy behavior as non-normative for their own social category. Health behaviors are thus not only influenced by personal choices but also by group norms that are associated with the social identity;

(3) Social identities have been recognized as a basis of *social support*. More specifically, individuals' experience of contact with others is affected by the extent to which they share a social identity with those people. The more individuals who give and receive support share a relevant social identity, the more their interaction will positively influence their health. Furthermore, the beneficial effects will be most apparent when social support is interpreted in the spirit in which it is intended (Jetten et al., 2011);

(4) A sense of shared social identification might strengthen the capacity for members of the same disadvantaged social category to work together and protect their well-being and mental health. Social categorization can therefore be acknowledged as a *coping mechanism* in that it fosters individuals' willingness to engage in health promoting behavior when they are confronted with group-based discrimination (Jetten et al., 2011);

(5) *Maintained* social identification has been demonstrated to play a role in *sustained health* of vulnerable populations. In this respect, social identity loss (e.g., due to illness, unemployment, retirement) might decrease individuals' mental functioning. Interventions that aim to maintain or increase individuals' sense of shared identity are therefore expected to be beneficial for the health and well-being of vulnerable populations (e.g., De Witte, 2003). The abovementioned identity-based determinants of health endorse the following statement of Putnam (2000): "We do not participate in group life because we feel well, but we are more likely to feel well because we participate in group life."

5. Objectives and outline of the thesis

This doctoral thesis is a compilation of five scientific articles that are published, accepted for publication (in press) or submitted. Given that multiple articles proceeded from the same intervention study, there might be some overlap between two or more articles, in particular with respect to the methodological section. The style applied in each of the articles is in accordance with the guidelines of the particular journal.

The general aim of this thesis was to examine the extent to which the Self-Determination Theory and the Self-Categorization Theory contribute to the adoption and maintenance of physical activity behavior among (older) adults. More specifically, we studied (1) whether creating a need-supportive environment yields autonomous forms of motivation and consequently sustained behavioral changes with respect to physical activity in different population groups who did not attain the physical activity recommendations for health, i.e. employees and older adults; and (2) whether, in addition to need-supportive physical activity counseling, integrating group processes and postulating social identity-based normative support for physical activity produce long-term physical activity behavior among older adults.

In order to study the abovementioned general aim, three longitudinal interventions were implemented: (1) a physical activity intervention based on the Self-Determination Theory among insufficiently active university employees (**Part 2**); (2) a physical activity intervention based on the Self-Determination Theory among insufficiently active older adults (**Part 3**); and (3) a physical activity intervention based on the Self-Categorization Theory among insufficiently active older adults (**Part 4**). We evaluated the effects of each intervention on physical activity behavior on the one hand and on health and well-being on the other hand. More specifically, in Chapter 2.1, Chapter 3.1 and Chapter 4.1, we described the long-term effects of various physical activity promoting strategies on physical activity. In Chapter 2.2, Chapter 3.2 and Chapter 4.1, we focused on the long-term effects of the physical activity programs on different dimensions of subjective well-being. An overview of the characteristics of the intervention studies is provided in Table 1. A brief description of the rationale and the objectives of each of the chapters are provided in the following paragraphs.

5.1. Outline of Part 2

Although it is assumed that Self-Determination Theory-based interventions facilitate sustained health behavioral changes, most studies on need-supportive counseling have been cross-sectional or have only focused on post-intervention physical activity changes. Previous studies based on the Self-Determination Theory have been less conclusive on the effectiveness of need-supportive interventions in the *long term*, i.e. six months or more after the intervention. A second limitation in Self-Determination Theory-based literature constitutes the lack of need-supportive studies examining the effectiveness on (different dimensions of) *well-being*. Nevertheless, the Self-Determination Theory assumes that the satisfaction of the three basic psychological needs is not only important to facilitate sustained behavioral changes but also to experience an ongoing sense of integrity and well-being. Furthermore, even though

understanding the mechanisms of effective intervention procedures would be helpful to develop successful health promoting strategies, studies examining the *mediating influences* of different process measures on health outcomes are limited, especially in the long term. Finally, in order to translate research into the wider community, the *cost-effectiveness* of the applied counseling strategy should be considered. However, the majority of physical activity interventions involve intensive counseling procedures, which hampers large-scale implementation.

Therefore, the aim of the first intervention study was to examine the short-term (i.e. immediately after the intervention) and long-term (i.e. one year after the intervention) effects of need-supportive physical activity counseling on physical activity (**Chapter 2.1**) and physical and psychological well-being (**Chapter 2.2**). Flemish university employees not attaining the physical activity recommendations for health were assigned to a control or an intervention condition. Participants of the control condition did not receive any physical activity instruction or counseling. Participants of the intervention condition received a four-month physical activity coaching based on the Self-Determination Theory. The coaching was limited to five individual contact moments with a bachelor in Kinesiology specializing in health-related physical activity counseling. Besides studying the intervention effects on physical activity and well-being, we evaluated the mediating influence of various psychological constructs (i.e. autonomous motivation, self-efficacy, social support) on physical activity, and of physical activity on well-being.

5.2. Outline of Part 3

Given that ageing may involve feelings of reduced personal control and competence, the Self-Determination Theory seems particularly relevant and applicable to the older adult population. However, most of the need-supportive physical activity interventions have focused on younger and adult populations whereas the framework of the Self-Determination Theory has yet to be applied in interventions among *older adults*, especially in the long term. A second limitation in the literature on physical activity promotion constitutes the assessment of physical activity behavior. Although *objective sensors* are assumed to provide a more complete and accurate measurement of physical activity than self-reports, most research on lifestyle and need-supportive physical activity counseling has relied on self-reported physical activity. Third, the effectiveness of physical activity in the treatment of anxiety and depression has been demonstrated. Given the high prevalence of mental disorders in older adults, it should also be valuable to evaluate the potential of physical activity in the prevention of *psychological health problems* among healthy populations. Nevertheless, physical activity interventions among non-clinical samples have mainly focused on positive health outcomes (e.g., mood) whereas physical activity studies involving clinical populations have rather examined the effects on negative components of subjective health (e.g., anxiety). Fourth and finally, although lifestyle interventions involve a limited number of contact moments between coach and client, they are still time- and labor-intensive and thus prevented from large-scale implementation. Nevertheless, no studies have compared the effectiveness of *one-contact physical activity counseling procedures* with more time-consuming need-supportive lifestyle coaching.

Therefore, the aim of the second intervention study was to compare the short-term (i.e. immediately after the intervention) and long-term effects (i.e. one year and two years after the intervention) on physical activity (**Chapter 3.1**) and indicators of subjective well-being (**Chapter 3.2**) of three physical activity counseling strategies varying in counseling procedure and intensity among Flemish older adults who did not attain the physical activity recommendations for health. The first counseling procedure involved a referral to existing physical activity programs. During a single 15-minute contact with a Health Fitness Specialist, participants received a self-help booklet with practical information on local physical activity opportunities. The second strategy embraced the provision of an individualized walking program. During a single 15-minute contact, a Health Fitness Specialist explained, in addition to the self-help booklet, a structured walking program. Due to its structured format, the walking program was assumed to inherently support participants' need for competence, and could therefore be considered as partially need-supportive. The third counseling method involved the provision of a ten-week individually-tailored physical activity program that was assumed to be fully need-supportive. This procedure consisted of a multiple-contact coaching by a Health Fitness Specialist who explicitly fostered participants' needs for autonomy, competence and relatedness.

The secondary aim of this intervention study was to test whether autonomous motivation mediated the intervention effect on physical activity and whether perceived need-support and changes in physical activity contributed to well-being. The Self-Determination Theory assumes autonomous motivation as a crucial concept to explain sustained behavioral changes. Consequently, evidence for the mediating role of autonomous motivation would provide further support for the validity and utility of this theoretical framework with respect to physical activity promotion among older adults.

5.3. Outline of Part 4

Group membership and being embedded in a social network are assumed to be essential to adopt and maintain (health-enhancing) behavior such as physical activity. More specifically, it has been demonstrated that besides supporting individuals' personal needs (which is consistent with the Self-Determination Theory), emphasizing their relatedness at the social level of the self facilitates behavioral change and positively affects their health and well-being. Consequently, individuals should define their sense of self not just in personal terms but also in *social terms* in order to obtain behavioral changes. In this respect, the Self-Categorization Theory proposes multiple levels at which individuals can define themselves, i.e. as an individual, as a member of a social group or as a human. Previous research has already provided support for the role of social identification as an additional determinant of behavior, as displayed by Ajzen's Theory of Planned Behavior (1991). In particular, associating positive descriptive norms with a relevant reference group has been shown to increase individuals' (intention to engage in) health behavior. However, to our knowledge, no studies have evaluated the effectiveness of a Self-Categorization Theory approach compared with a Self-Determination Theory approach within the domain of physical activity promotion, neither in the short term nor in the long term. Nevertheless, it is assumed that (1) both targeting

individuals' social self and targeting their personal self contribute to behavioral change, and (2) identifying oneself with different levels of self-categorization may have distinct implications for one's behavior.

Therefore, the aim of the third intervention study was to compare the short-term (i.e. immediately after the intervention) and long-term effects (i.e. one year after the intervention) on physical activity (**Chapter 4.1**) and subjective well-being (**Chapter 4.1**) of three six-week identity-based physical activity counseling procedures among Flemish older adults who did not attain the physical activity recommendations for health. The first counseling strategy consisted of an individually-tailored and need-supportive physical activity coaching based on the Self-Determination Theory in which participants' personal identity was targeted. During weekly contact, a Health Fitness Specialist explicitly supported participants' need for autonomy, need for competence and need for relatedness at the personal level of the self. The secondary counseling procedure comprised a physical activity promoting strategy based on the Self-Categorization Theory in which participants' social self was targeted. During weekly contacts, a Health Fitness Specialist provided social identity-based normative support for physical activity, and in particular for walking. More specifically, walking behavior was proposed as prototypical for a relevant reference group within this population group. In a preliminary survey, we aimed at determining appropriate reference groups in this population to be used in the physical activity intervention. The third physical activity promoting strategy embraced physical activity counseling in which a Health Fitness Specialist facilitated participants' physical activity behavior by targeting their personal ánd social identity during weekly contact. This counseling method was based on both the Self-Determination Theory and the Self-Categorization Theory.

The secondary aim of this intervention study was to test whether the intervention effects on physical activity and well-being could be explained by theoretically-grounded processes. First, consistent with the Self-Determination Theory, we evaluated the mediating influence of identified regulation on the relationship between perceived need-support and physical activity. Second, consistent with the Self-Categorization Theory, we evaluated the mediating influence of integrated regulation on the relationship between perceived normative support for physical activity and physical activity behavior. Furthermore, we evaluated the extent to which participants' physical activity level, their perceived need-support and their degree of identification with relevant social identities contributed to their subjective well-being.

5.4. Outline of Part 5

Part 5 comprises the general discussion of this doctoral thesis, including the main findings of the three intervention studies and an overall conclusion. Furthermore, the strengths and limitations of the three interventions are summarized, assessment tools of physical activity are considered, practical implications of the various health promoting strategies are discussed and recommendations for future research are formulated.

Table 1. Characteristics of the physical activity intervention studies

	INTERVENTION STUDY 1	**INTERVENTION STUDY 2**	**INTERVENTION STUDY 3**
	Individually-tailored need-supportive physical activity counseling	**Structured walking program**	**Social identity-based physical activity counseling**
Participants	Insufficiently active employees of KU Leuven (n = 92)	Flemish insufficiently active older adults (≥ 60 years) (n = 146)	Flemish insufficiently active older adults (55-70 years) (n = 57)
Coach	Bachelors in Kinesiology specializing in health-related physical activity (n = 30)	Health Fitness Specialists (MSc) (n = 3)	Health Fitness Specialist (MSc) (n = 1)
Intervention duration	Four months	Ten weeks	Six weeks
Counseling strategy	Five individual contact moments: - Face-to-face intake - Three follow-ups, either face-to face, by phone or by email - Face-to-face outtake	- Single 15-minute contact - Provision of a structured walking program	Six individual contact moments: - Face-to-face intake - Two contacts by email - Two contacts by post - Face-to-face outtake
Theoretical framework	Self-Determination Theory	Self-Determination Theory	Self-Categorization Theory
Comparison condition	Waiting-list control condition (n = 34)	- One-contact physical activity referral (n = 146) - Multiple-contact individually-tailored need-supportive physical activity counseling (n = 150)	- Personal identity-based (i.e. individually-tailored need-supportive) physical activity counseling (n = 56) - Joined (i.e. personal and social) identity-based physical activity counseling (n = 56)

Table 1. Characteristics of the physical activity intervention studies (continued)

	INTERVENTION STUDY 1	**INTERVENTION STUDY 2**	**INTERVENTION STUDY 3**
	Individually-tailored need-supportive physical activity counseling	**Structured walking program**	**Social identity-based physical activity counseling**
Measurements	Baseline Post-intervention One-year follow-up	Baseline Post-intervention One-year follow-up Two-year follow-up	Baseline Post-intervention One-year follow-up
Primary outcomes	Self-reported physical activity: - Mild intensity physical activity - Moderate intensity physical activity - Strenuous intensity physical activity Physical well-being Psychological well-being	Self-reported physical activity Pedometer-based daily steps Subjective well-being Trait-anxiety	Self-reported physical activity Pedometer-based daily steps Pedometer-based daily aerobic minutes Self-rated health Physical well-being Psychological well-being
Process outcomes	Self-efficacy Social support Autonomous motivation Perceived need-support	Autonomous motivation Perceived need-support	Autonomous forms of motivation: - Identified regulation - Integrated regulation Degree of identification with social identity: - Physical activity identity - Socially engaged persons - Independent persons Perceived need-support Perceived normative support for physical activity

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Part 2

Physical activity promotion based on the Self-Determination Theory among insufficiently active university employees

CHAPTER 2.1

Long-term effectiveness and mediators of a need-supportive physical activity coaching among Flemish sedentary employees

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Abstract

This study examined the long-term and mediation effects of a need-supportive coaching programme on physical activity. Sedentary employees (*n* = 92) of the KU Leuven received four months of physical activity coaching, based on the Self-Determination Theory, by coaches with a bachelor's degree in Kinesiology who are specializing in health-related physical activity (*n* = 30). The programme consisted of a limited number of individual contact moments (i.e. an intake session, three follow-up contacts and an outtake session), either face-to-face, by phone or by email. Self-reported physical activity, social support, self-efficacy and autonomous motivation were assessed in the coaching condition (*n* = 92) and a control condition (*n* = 34) at three moments: before the intervention (i.e. pre-test), immediately after the intervention (i.e. post-test) and one year after pre-test measurements (i.e. follow-up-test). Results revealed significant 3 (time) x 2 (conditions) interaction effects on strenuous and total physical activity. Moreover, the coaching condition increased significantly in moderate, strenuous and total physical activity from pre- to post-test whereas the control condition remained stable. Additionally, the coaching condition increased significantly in mild, moderate, strenuous and total physical activity from pre- to follow-up-test whereas no changes emerged in the control condition. Bootstrapping analyses indicated that self-efficacy and autonomous motivation significantly mediated the intervention effect on physical activity from pre- to post-test. Social support significantly mediated the long-term effect. This study provides evidence for the long-term effectiveness of a need-supportive physical activity programme that might be efficient at community level.

Keywords: physical activity, behaviour change, intervention, longitudinal survey

Introduction

Regular physical activity is considered to be a major contributor to physical and psychological health and well-being (e.g., Kohl, 2001; Roglin et al., 2007). However, the majority of the population in Western societies does not attain the physical activity health norm prescribed by the American College of Sports Medicine (Varo et al., 2003; Philippaerts et al., 2006; Gisle et al., 2010). Therefore, the promotion of physical activity has been identified as public health priority (Pate et al., 1995; Golditz, 1999). Numerous studies have demonstrated increased physical activity levels by implementing lifestyle interventions, in which physical activity is incorporated into one's daily routines (e.g., Dunn et al., 1998; Opdenacker et al., 2008). Among the overall reported positive results, theory-based lifestyle interventions have been found to be most effective (Hillsdon et al. 2005; U.S. National Cancer Institute, 2005).

In the past decade, the Self-Determination Theory (SDT) has been postulated as a promising theoretical approach to facilitate behavioural change, and in particular to increase physical activity (e.g., Chatzisarantis and Hagger, 2009). SDT assumes that people possess three basic psychological needs, i.e. the need for autonomy, the need for competence and the need for relatedness. These needs are considered as fundamental to obtain high-quality motivated engagement in any given behaviour (Deci and Ryan, 1985). The need for autonomy reflects the desire to be the origin of one's own behaviour and can be satisfied by using client-centered strategies such as exploring options and letting the client make decisions. The need for competence implies the pursuit of experiencing success in producing desired outcomes and can be fulfilled by appropriate goal-setting and providing positive feedback. Finally, the need for relatedness refers to the feeling that one belongs to a meaningful social environment and can be supported by expressing empathy and avoiding judgement or criticism (Deci and Ryan, 1985; Hardcastle and Hagger, 2011). An environment that fulfills the needs for autonomy, competence and relatedness, has been shown to be effective in facilitating autonomous motivation (AM). Autonomously motivated behaviour is likely to persist in the long term because it is initiated by the individual, and thus self-determined (Deci and Ryan, 1985; Markland and Vansteenkiste, 2007; Silva et al., 2010a, b).

Within the psychology of health behaviour change, motivational interviewing (MI) has been recognized as an appropriate collaborative counselling technique to create such a need-supportive environment (Miller and Rollnick, 2002; Markland et al., 2005, 2007). Furthermore, MI has been shown to increase individuals' self-efficacy (SE). The concept of SE refers to the belief of one's capability to perform a task (Ajzen, 1991; Bandura, 1997) and is related to the SDT's concept of perceived competence (Biddle, 1999; Markland et al., 2005). Moreover, SE has been proposed as a mediating factor in enhancing behavioural change, e.g. physical activity (e.g., Dishman et al., 2004; Markland et al., 2005; Taymoori and Lubans, 2008). In addition to SE, social support (SOSU) has been identified as an important psychosocial variable in increasing physical activity among sedentary populations (e.g., Eyler et al., 1999; De Bourdeaudhuij and Sallis, 2002). The creation of a need-supportive environment that focuses on increasing individuals' SE and advances supportive relationships by significant others can thus be assumed as a beneficial strategy to promote physical activity.

Although numerous studies have linked need-supportive coaching to increased physical activity levels (e.g., Wilson et al., 2003; Chatzisarantis and Hagger, 2009), previous research has been less conclusive on the long-term effectiveness of such an intervention (National Heart, Lung and Blood Institute, 1998; Fortier et al., 2007; Silva et al., 2010a, b). Furthermore, relatively few studies have examined the mediating influence of theoretical constructs on the relation between a SDT-based intervention and physical activity, especially in the long term (Edmunds et al., 2006; Haerens et al., 2008; Fortier et al., 2011). Nevertheless, knowledge of mediation effects can contribute to the effectiveness of physical activity interventions. Finally, the majority of intervention studies involve intensive counselling procedures. However, these strategies are rather difficult to implement on a large scale (Haerens et al., 2008; Silva et al., 2010a, b).

Therefore, the present study was designed to examine (1) the (long-term) physical activity effects of a need-supportive coaching programme, consisting of a limited number of contact moments, among sedentary employees; and (2) the mediation effects of SOSU, SE and AM within this coaching process. It was hypothesized that the intervention condition (COACH) would increase their physical activity level whereas no changes would emerge in the control condition (CONTR). Moreover, because the need-supportive intervention was intended to change the underlying psychosocial constructs, changes in physical activity were expected to be mediated by changes in SOSU, SE and AM.

Method

Recruitment and participants

Data were derived from a physical activity coaching project at the KU Leuven. Participants (n = 92) were sedentary employees of the university, who had been offered the opportunity to be counselled by a personal physical activity coach (n = 30). Recruitment took place via personal mailing and an announcement in a monthly internal newsletter, and resulted in 382 volunteers. A two-stage procedure was followed to reduce the total number of volunteers to 90 participants in COACH, i.e. three per coach: (1) volunteers were asked to indicate whether they already attained the physical activity health norm prescribed by the American College of Sports Medicine (Haskell et al., 2007) (yes / no-question) and to specify their weekly physical activity pattern. Those who already attained the norm of 30 minutes of moderate intensity physical activity on at least five days a week or 20 minutes of strenuous intensity physical activity on at least three days a week were refused (n = 36); (2) The 'first come - first served' principle was applied, meaning that volunteers who responded first on the recruitment announcement were invited to participate in the intervention. Two participants who dropped out shortly after the intake session (see section below) were immediately replaced, which resulted in 92 participants in COACH. The CONTR consisted of the 34 subsequent volunteers who met the inclusion criteria. Considering that the majority of volunteers responded on the recruitment message within two days, the participants included in COACH were not considered to be more motivated than volunteers included in CONTR.

At post-test, dropout rates were 6.5% in COACH and 0.0% in CONTR (χ^2 = 2.261, p = .152). Dropout rates at follow-up were 13.0 and 11.8%, respectively (χ^2 = 0.019, p = .580). A lack of motivation was the most frequently reported reason for dropping out. There were no significant differences between dropouts and

non-dropouts between COACH and CONTR with respect to demographic variables, self-reported physical activity, SOSU, SE and AM at pre-tests.

Procedures and intervention

The four-month intervention took place from November 2009 to March 2010 and consisted of five contact moments between the coach and participants of COACH (i.e. an intake session, three follow-up contacts and an outtake session). Participants of COACH and CONTR completed measurements at pre-, post- and follow-up-tests before, immediately after and one year after the beginning of the intervention, respectively. No contact occurred between coach and participants between post- and follow-up-tests. Participants of CONTR completed all measurements under the supervision of a coach. However, they did neither receive physical activity instructions nor a programme.

Coaches were recently graduated with a bachelor's degree in Kinesiology and were specializing in health-related physical activity to get their master's degree. Prior to the coaching, they had attended a course in psychology of behavioural motivation and physical activity promotion in order to improve their coaching proficiency according to SDT and MI. Additionally, regular feedback from experts during the coaching procedure ensured high-quality coaching.

During a face-to-face intake session of approximately one hour, an individualized physical activity programme was set up in accordance with the participants' preferences, habits and opportunities. The physical activity goals, specified by physical activity type, location, time frame, company, barriers and solutions were written down in an agreement. The main goal was to attain the physical activity health norm as prescribed by the American College of Sports Medicine (Haskell et al., 2007).

The three follow-up contacts and the outtake session took place three to four weeks after the previous contact. According to previous research, face-to-face support is as efficacious as support by phone or computer-based support in targeting behavioural changes, e.g. physical activity (Opdenacker and Boen, 2008; Portnoy et al., 2008). Therefore, the second and third follow-up contact occurred face-to-face, by phone or by email, depending on the participants' need. Follow-up contacts occurred face-to-face, by phone and by email among respectively, 98.5%, 30.7% and 67.7% of the clients. Face-to-face and follow-up contacts by phone lasted approximately 30 and ten minutes, respectively, while conversations by email consisted of four emails. During follow-up contacts, the student-coaches asked for the degree of adherence to the programme (i.e. did the participant reach his / her physical activity goals), identified possible barriers and, if necessary, modified goals. The coaches motivated the clients to persist in their programme by using behaviour change techniques (Abraham and Michie, 2008) and by coaching according to the principles of MI and SDT. Specifically, they prvided autonomy support (e.g., by facilitating rather than prescribing physical activity), competence support (e.g., by providing positive feedback) and relatedness support (e.g., by expressing empathy through active listening).

The outtake session was planned to evaluate behaviour change among the participants, to make sure the participants mastered the required techniques to continue engagement in physical activity (e.g., barrier identification, using prompts and cues) and to discuss future challenges.

Questionnaires

Self-reported physical activity was assessed with a modified version of the Godin Leisure-Time Exercise Questionnaire (GLTEQ) (Godin and Shephard, 1985). The GLTEQ is brief, easy to administer and considered to be clearly comprehensible for a diverse population. The validity and test-retest reliability have already been demonstrated in Western populations (Godin and Shephard, 1985; Jacobs et al., 1993; Karvinen et al., 2007). Furthermore, the GLTEQ has been successfully employed in different populations in Western societies (e.g., Karvinen et al., 2007; De Bacquer et al., 2010; Rhodes and Pfaeffli, 2010). Participants reported the number of times they engaged for at least 20 minutes in mild, moderate and strenuous intensity physical activity in a typical week during the past month. An overall measure of self-reported physical activity was obtained by summing the frequencies weighted by the metabolic equivalents for each intensity category, i.e. three, five and nine, respectively.

SOSU was measured by a validated five-point Likert scale from De Bourdeaudhuij and Sallis (2002). Participants were asked how strongly they believed that family, friends and colleagues wanted them to be physically active (three items) and how frequently they perceived support (i.e. accompany, propose, remind and encourage) from these significant others with respect to physical activity (12 items). Cronbach's alpha coefficients for pre-, post- and follow-up-tests ranged from .82 to .86, indicating a high internal consistency.

SE was measured by a multi-dimensional Self-Efficacy Questionnaire (Opdenacker et al., 2008). Participants indicated their confidence level for being physically active in various situations, on a five-point Likert scale, ranging from 'not at all confident' to 'very confident'. Internal consistency was very high with Cronbach's alpha coefficients for pre-, post- and follow-up-tests ranging from .90 to .93.

AM was assessed with eight items of the Dutch version of the Behavioural Regulations for Exercise Questionnaire (Markland and Tobin, 2004). This self-determined type of motivation comprises the subscales of identified regulation (four items) and intrinsic motivation (four items) (Fortier and Kowal, 2007) and has been shown to be positively associated with long-term physical activity behaviour (Pelletier et al., 2001; Chatzisarantis et al., 2003; Vansteenkiste et al., 2004). Cronbach's alpha coefficients for pre-, post- and follow-up-tests ranged from .88 to .90, indicating a high internal consistency.

Statistical analysis

All data were analysed with SPSS 16.0 (SPSS, Inc., Chicago, IL, USA). To assess differences between COACH and CONTR, one-way ANOVA and χ^2 analyses were used. One person with a pre-test GLTEQ score more than three standard deviations above the pre-test mean was excluded from all analyses. Effects on physical activity were analysed with repeated measurements ANOVAs. Multivariate analyses (Phillai's trace coefficient) were conducted to test several dependent variables simultaneously. Mediation effects were analysed with the bootstrapping macro provided by Preacher and Hayes (2008). The primary advantage of bootstrapping is that no assumptions are made about the shape of sampling distribution of the indirect effect (Preacher and Hayes, 2008). Change scores of SOSU, SE and AM were included simultaneously in a multiple mediator model, because this (1) 'purifies' the indirect effects by controlling for all the other mediators, and

(2) allows the researcher to determine which mediators are more successful than others (Preacher and Hayes, 2008). Mediation analyses were conducted for change scores from pre- to post-test (Δprepo) and from pre- to follow-up-tests (Δprefu). The significance level was set at $p \leq .05$.

Results

Demographic profile

The participants' mean age was 41.3 years (SD = 13.6). There were 52.0% men and most participants were married or lived together with their partner (71.2%). Twenty-seven per cent of the participants were technical employees whereas professors and research assistants represented 20.8% and 37.0%, respectively. A minority of the participants (e.g., emeritus professors, partners of university employees) were not employed at the university (15.2%). No significant differences emerged between COACH and CONTR with respect to the abovementioned demographic variables

Effect analyses

Table 1 depicts the physical activity means (SD) at pre-test, the pre- to post-test and pre- to follow-up-test change scores for physical activity, the 3 (time) x 2 (conditions) interaction effects and the one-way ANOVAs for the physical activity change scores. Significant 3 (time) x 2 (conditions) interaction effects emerged on strenuous and total physical activity, indicating that the reported strenuous and total physical activity in COACH changed differently over time compared with CONTR. Furthermore, while no changes occurred in CONTR, participants of COACH showed significant increases in moderate, strenuous and total physical activity from pre- to post-test and in all intensity physical activities from pre- to follow-up-tests (all $p < .001$). One-way ANOVA analyses revealed significant differences in Δprepo for moderate, strenuous and total physical activity (Pillai's trace: $F = 9.463$, $p < .001$) and in Δprefu for strenuous and total physical activity (Pillai's trace: $F = 3.715$, $p = .014$) between COACH and CONTR. Despite their lower pre-test levels of strenuous and total physical activity (strenuous physical activity: $F = 7.419$, $p = .007$; total physical activity: $F = 7.965$, $p = .006$), participants in COACH reported higher levels of physical activity at post-test (strenuous physical activity: $F = 5.346$, $p = .023$; total physical activity: $F = 8.570$, $p = .004$).

Mediation

Because significant 3 (time) x 2 (conditions) interaction effects emerged on strenuous and total physical activity, mediation effects of changes in SOSU, SE and AM on changes in strenuous and total physical activity were tested (Table 2). The paths from the intervention to pre- to post-test change scores in SE and AM (α-paths) were significant, indicating that participants in COACH increased more in SE and AM from pre- to post-test than participants in CONTR (Pillai's trace: $F = 3.421$, $p = .020$). By contrast, the α-path on SOSU failed to reach significance, indicating no differences in changes in SOSU between COACH and CONTR from pre- to post-test. Furthermore, the ß-paths from pre- to post-test changes in the proposed mediators to changes in strenuous and total physical activity were not significant. Finally, the confidence intervals of the indirect

pathways via the proposed mediators (i.e. SOSU, SE and AM) (αß-paths) showed that Δprepo in SE significantly mediated the effect of the intervention on changes in strenuous and total physical activity. Moreover, Δprepo in AM significantly mediated the intervention effect on changes in strenuous physical activity. The overall mediation models accounted for respectively 19.2% (F = 6.780, p < .001) and 21.4% (F = 7.775, p < .001) of the variance in Δprepo in strenuous and total physical activity.

Table 1. Means (SD) at pre-test, pre- to post-test and pre- to follow-up-test change scores for physical activity in COACH and CONTR, 3 (time) x 2 (conditions) interaction effects and one-way ANOVAs for physical activity change scores from pre- to post-test and from pre- to follow-up-test.

		COACH	**CONTR**	**3 x 2 INTERACTION**		**One-way ANOVA**	
		Mean (SD)	**Mean (SD)**	***F***	***η²***	***F***	***η²***
Mild PA	pre	1.01 (1.75)	1.35 (1.74)	1.952	.018		
(times a week for ≥ 20	Δprepo	+ 0.20	+ 0.10			0.067	.001
minutes)	Δprefu	+ 0.82	- 0.25			3.228	.029
Moderate PA	pre	0.92 (1.64)	1.38 (1.37)	2.122	.020		
(times a week for ≥ 20	Δprepo	+ 1.45	+ 0.39			5.765 *	.047
minutes)	Δprefu	+ 1.98	+ 0.78			2.302	.021
Strenuous PA	pre	0.22 (0.56)	0.66 (1.04)	5.882 **	.054		
(times a week for ≥ 20	Δprepo	+ 0.96	- 0.01			14.291 ***	.109
minutes)	Δprefu	+ 0.85	+ 0.12			5.852 *	.052
Total PA	pre	9.61 (9.58)	16.83 (12.72)	8.998 ***	.080		
(GLTEQ)	Δprepo	+ 16.46	+ 2.17			23.277 ***	.166
	Δprefu	+ 19.95	+ 4.24			9.849 **	.084

Note. PA, physical activity; COACH, intervention condition; CONTR, control condition; GLTEQ, Godin Leisure-Time Exercise Questionnaire; SD, standard deviation; pre, pre-test value; Δprepo, change score from pre- to post-test; Δprefu, change score from pre- to follow-up-test; 3 x 2 INTERACTION, interaction effect over time (3) and between conditions (2) for mild, moderate, strenuous and total physical activity; One-way ANOVA, difference between the intervention and control condition for change scores in physical activity; *, p < .05; **, p < .01; ***, p < .001

No significant effects were found from the intervention on changes in the proposed mediators from pre- to follow-up-tests (α-path) (Pillai's trace: F = 0.935, p = .427). Nevertheless, the significant direct effects of Δprefu in SE and AM on Δprefu in strenuous physical activity (ß-path) indicated that the more participants increased in SE and AM from pre- to follow-up-tests, the more they increased their level of strenuous physical activity from pre- to follow-up-tests. Finally, Δprefu in SOSU significantly contributed to the indirect effect of the intervention on Δprefu in total physical activity (αß-paths). The overall models explained 19.0% (F = 5.968, p < .001) and 16.5% (F = 5.024, p = .001) of the variance in Δprefu in strenuous and total physical activity, respectively.

Table 2. Mediation effects of changes in social support, self-efficacy and autonomous motivation on changes in strenuous and total physical activity.

		α-path coefficient (SE)	β-path coefficient (SE)	αβ-path coefficient (SE)	95% CI of αβ
Δprepo					
Strenuous PA					
(times a week for ≥ 20 minutes)	Δprepo SOSU	- 0.208 (0.123)	0.274 (0.182)	- 0.055 (0.068)	- 0.290 to 0.022
	Δprepo SE	- 0.267 (0.119) *	0.274 (0.206)	- 0.089 (0.056)	- 0.238 to - 0.014
	Δprepo AUM	- 0.257 (0.102) *	0.373 (0.240)	- 0.092 (0.064)	- 0.280 to - 0.005
	Total			- 0.236 (0.096)	- 0.502 to - 0.094
Total PA					
(GLTEQ)	Δprepo SOSU	- 0.208 (0.123)	1.698 (2.292)	- 0.312 (0.668)	- 2.494 to 0.566
	Δprepo SE	- 0.267 (0.120) *	4.903 (2.596)	- 1.323 (0.786)	- 3.380 to - 0.175
	Δprepo AUM	- 0.257 (0.102) *	2.191 (3.022)	- 0.531 (0.808)	- 2.529 to 0.720
	Total			- 2.166 (1.057)	- 4.728 to - 4.000
Δprefu					
Strenuous PA					
(times a week for ≥ 20 minutes)	Δprefu SOSU	- 0.231 (0.137)	0.113 (0.197)	- 0.028 (0.052)	- 0.190 to 0.044
	Δprefu SE	- 0.022 (0.154)	0.465 (0.190) *	- 0.011 (0.059)	- 0.147 to 0.097
	Δprefu AUM	- 0.028 (0.128)	0.460 (0.227) *	- 0.016 (0.060)	- 0.179 to 0.083
	Total			- 0.055 (0.113)	- 0.308 to 0.137
Total PA					
(GLTEQ)	Δprefu SOSU	- 0.231 (0.137)	5.421 (3.338)	- 1.172 (0.929)	- 3.989 to - 0.011
	Δprefu SE	- 0.022 (0.154)	6.211 (3.213)	- 0.063 (0.812)	- 2.079 to 1.394
	Δprefu AUM	- 0.028 (0.128)	2.046 (3.840)	- 0.014 (0.520)	- 1.760 to 0.671
	Total			- 1.249 (1.454)	- 5.243 to 0.983

Note. PA, physical activity; GLTEQ, Godin Leisure-Time Exercise Questionnaire; SOSU, social support; SE, self-efficacy; AUM, autonomous motivation; Δprepo, change score from pre- to post-test; Δprefu, change score from pre- to follow-up-test; α, estimate of the intervention effect on changes in the proposed mediators; β, estimate of the direct effect of changes in the proposed mediators on changes in physical activity while controlling for the intervention effect; αβ, estimate of the indirect effect of the intervention on changes in physical activity through the proposed mediators; 95% CI, 95% bias corrected confidence interval with the empirically derived bootstrapped sampling distribution of αβ (result of 2000 bootstrap resamples); *, $p < .05$

Discussion

The results of this study showed that need-supportive coaching with a limited number of contact moments is effective in increasing physical activity among sedentary university employees. This finding is in line with previous SDT-based intervention studies (e.g., Edmunds et al., 2008; Chatzisarantis and Hagger, 2009; Silva et al., 2010a, b) and extends previous research by demonstrating effectiveness in the long term. Both the increased physical activity level from pre- to post-test in COACH and the remained physical activity level from post- to one-year follow-up-test are consistent with research of Opdenacker et al. (2008). More specifically,

these findings provide evidence for exercise engagement and persistence as a result of a need-supportive coaching environment.

In line with previous SDT-based research (Edmunds et al., 2006; Silva et al., 2010a, b), different intensities of physical activity were evaluated. Specifically, mild physical activities are regarded as habitual lifestyle activities (e.g., walking for transportation) whereas moderate and strenuous physical activities are considered to be more purposeful and structured. In this respect, higher intensity physical activities might require more cognitive processing (Edmunds et al., 2006; Silva et al., 2010a, b). The substantial increases in moderate and strenuous physical activities suggest that need-supportive counselling is especially effective in facilitating engagement in higher intensity physical activities. Moreover, the increase in higher intensity physical activity from pre- to post-test in COACH suggest that, during the intervention, the coaches mainly encouraged the participants to incorporate structured physical activities of moderate to high intensity into their individualized physical activity programme (e.g., following dancing classes or going for a swim once a week). Furthermore, given that a higher level of cognitive processing is associated with higher intensity physical activities, moderate and strenuous physical activities were possibly easier to remember than mild physical activities, and therefore more likely to be reported on the physical activity questionnaire. The increased moderate and strenuous intensity physical activity in COACH is especially important because previous research has demonstrated that a higher intensity of performed physical activity results in greater aerobic and cardioprotective benefits (Williams, 1998; Swain and Franklin, 2006).

From pre- to follow-up-test, increases were not only found in higher intensity physical activities but also in physical activities of mild intensity. This means that, in the long run, participants integrated habitual activities such as active transportation in their daily life, in addition to the structured physical activities. This finding indicates the potential of a need-supportive physical activity coach to facilitate individuals' engagement in mild physical activities. However, it is also important to consider the impact of regulations at policy level on individuals' performance of mild physical activities, for example by ensuring a safe environment. Besides the impact of a need-supportive environment on individuals' engagement in mild intensity physical activities, participants' engagement in mild physical activities might have increased because of their engagement in structured physicalactivities. More specifically, assuming that the post-intervention increases in moderate and strenuous physical activities resulted in higher levels of physical fitness, participants might have been more physically fit, and therefore needed to exert less effort to integrate mild physical activities in their habitual life. Additionally, because CONTR also demonstrated small, albeit non-significant, increases in moderate physical activity from pre- to follow-up-tests, seasonal reasons (i.e. spring and summer) can partly explain the increase in moderate physical activities. However, the significant time by condition interaction effects from pre- to follow-up-tests for strenuous and total physical activity underscore the value of SDT-based coaching to facilitate the persistence in structured high intensity physical activities.

The impact of the need-supportive intervention on the proportion of individuals who attained the physical activity health norm should also be noted (Pate et al., 1995). Although the GLTEQ does not provide a precise measure of minutes that participants engaged in physical activity, the overall physical activity score obtained by this questionnaire can be considered as a general guideline to determine whether or not one

attains the recommended physical activity level. According to Haskell et al. (2007), health benefits can be obtained by performing 20 minutes of strenuous physical activity on at least three days a week. This corresponds with an overall score of 27 on the GLTEQ (Scheerder et al., 2011). The results of this study showed that the number of participants in COACH attaining a GLTE-score of 27, and thus obtaining the physical activity health norm, increased from 8.7% in pre-test to 41.9 and 48.8% in respectively, post- and follow-up-tests. Percentages in CONTR changed from 18.2% over 27.3 and 24.1%, respectively. At follow-up, the proportions of individuals attaining the physical activity health norm were significantly different between COACH and CONTR (χ^2 = 5.286, p = .017). Furthermore, one-way analyses revealed that participants who increased their physical activity level were less physically active at baseline compared with participants who decreased or did not change their physical activity level. This trend emerged for moderate, strenuous and total physical activity from pre- to post-test and for all intensities of physical activity from pre- to follow-up-test. The appearance of this trend corresponds with the identified significant time effects in COACH and suggests that these effects are mainly resulting from the increases in physical activity in the most sedentary participants. These results highlight the potential of a need-supportive physical activity coaching as a public health initiative, especially when targeting the most sedentary population.

Because understanding the role of underlying psychosocial constructs enlarges the insight in how an intervention works (Hillsdon et al., 2005), mediation effects of changes in SOSU, SE and AM on changes in physical activity were studied. Mediation analyses were conducted only on strenuous and total physical activity because these are considered to require a higher level of cognitive processing compared with less intensive physical activity. The results are in line with previous SDT-based studies, in which (changes in) physical activity could partly be explained by (changes in) SE and competence, which are closely related concepts (Edmunds et al., 2006; Fortier et al., 2007; Haerens et al., 2008). Moreover, previous research demonstrated positive relations between AM on the one hand and strenuous and total physical activity on the other hand (Edmunds et al., 2006; Silva et al., 2010a, b; 2011). Although the components of AM (i.e. identified regulation an intrinsic motivation) have been shown to contribute differently to the prediction of physical activity, both are proposed to be beneficial to optimal and continued exercise engagement (Edmunds et al., 2006). While identified regulation appears to be relevant for engagement in physical activity, intrinsic motivation is considered to be important for exercise persistence (Pelletier et al., 2001). Physical activity promotion should thus focus on increasing both types of motivation in order to be effective. The mediation by SOSU in the long term is consistent with previous research of De Bourdeaudhuij and Sallis (2002). This finding emphasizes the importance of interpersonal relationships as a determinant of physical activity and indicates the value of supporting individuals' need for relatedness during an intervention, e.g. by active listening, conveying empathy and using non-judgmental language. Furthermore, it highlights the importance of continued SOSU from significant others (e.g., family, friends, colleagues) during and after the intervention in order to enhance sustained physical activity.

In conclusion, the results partially supported our hypotheses and suggested that applying general behaviour change techniques (Abraham and Michie, 2008) and SDT-based counselling techniques such as providing options and focusing on task goals (i.e. autonomy support), setting realistic goals and providing

positive feedback (i.e. competence support) and showing empathy (i.e. relatedness support), is successful in promoting (long-term) physical activity through various psychosocial constructs.

The present study had its particular strengths and weaknesses. First, although coaches were only recently graduated with a bachelor's degree in Kinesiology and thus less experienced, the intervention demonstrated long-term effects on physical activity. This strengthens the potential of a SDT-based intervention to promote physical activity at community level. Second, the limited number of need-supportive contact moments between coach and client enhances the efficiency and large-scale implementation of physical activity initiatives, especially because previous research (Conn et al., 2002; Fortier et al., 2007) indicated that regular contact with a physical activity coach is more effective than limited contact. Individual need-supportive contact seems especially important in the beginning of physical activity coaching, in order to increase the clients' feelings of competence. However, it should be noted that need-supportive coaching remains time- and labour-intensive, even with a limited number of contact moments. Therefore, alternative coaching strategies or multi-sectoral and integrated approaches appear inevitable to advance large-scale physical activity promotion. Replacing individual contact moments by group sessions (e.g., in a socio-cultural organization) once the individual's competence level is sufficient could increase the feasibility of need-supportive coaching at community level. Furthermore, in addition to this midstream (i.e. lifestyle) approach that aims to directly influence individuals' behaviour (e.g., increase physical activity), upstream approaches are needed as well in order to obtain effective population-based prevention. More specifically, there is vast need for promotion actions within the broader socio-ecological and economic domain (e.g., education, finance, appropriate physical environment). The high level of physical inactivity within the population requires a policy response. Structural environmental changes (e.g., safe bicycle and footpaths) have been found to be promising steps to make healthy choices the easy choices (Östlin et al., 2006; Sacks et al., 2009). A third strength of the present study is the inclusion of a control condition within a longitudinal design. This allowed us to interpret the physical activity increases as an intervention effect rather than an attention effect.

Although the study included a control condition in which participants did not receive any physical activity counselling, the lack of strict randomization between the control and the intervention condition constitutes a first limitation. Because of ethical, educational and social reasons, the 'first come - first served' principle was applied. However, first responders (who were involved in COACH) did not demonstrate higher pre-test levels of SE or AM compared with slower responders (who were involved in CONTR). Therefore, it seems unlikely that the lack of strict randomization was responsible for the significant differences in strenuous and total physical activity at pre-test between COACH and CONTR. Second, physical activity was based on self-reports, which may have led to social desirability (Motl et al., 2005) and overestimation (Fogelholm et al., 2006). On the other hand, the questionnaire used in this study has been shown to have a reasonable validity and reliability (Godin and Shephard 1985). Moreover, the GLTE-score has been found to be positively correlated with maximum oxygen consumption (Jacobs et al., 1993) and activity monitoring (Kriska and Caspersen, 1997). Third, because more than half of the participants in this study were (emeritus) professors or research employees, the participants were highly educated compared with the Flemish population. Therefore, the results should be generalised with caution to the entire Flemish population. On the other hand, both the

gender distribution and age range of the participants (52.0% of men; 41.3 years) were representative for the Flemish population.

In conclusion, the findings of the present study provide support for the long-term effectiveness of a need-supportive physical activity coaching with limited contact through various psychosocial constructs. The study can be considered as a preliminary but promising step within the domain of efficient physical activity promotion at community level.

Endnote

The term 'sedentary' refers to 'not attaining the physical activity recommendations for health as prescribed by Haskell et al. (2007)', i.e. in addition to performing daily activities that last less than ten minutes or that are of mild intensity, accumulating at least moderate intensity aerobic physical activity for a minimum of 30 minutes on five days each week, in bouts of at least ten minutes, or strenuous intensity aerobic physical activity for a minimum of 20 minutes on three days each week, or a combination of moderate and strenuous intensity aerobic physical activity.

Participants were recruited out of the pool of employees of the KU Leuven. However, the demographic profile of the employees who participated in the study slightly differed from the profile of those who did not participate in the study (Personeelscijfers KU Leuven, 2009). More specifically, (emeriti) professors were somewhat overrepresented in the participants' sample compared with the overall employees' population of the KU Leuven. Consequently, the average age of the participants' sample was somewhat higher than the average age of all employees of the KU Leuven. Table 3 provides an overview of several demographics of the participants' sample compared with those of the overall employees' population of the KU Leuven.

Table 3. Demographic characteristics of the participants' sample compared with those of the entire employees' population of the KU Leuven in 2009.

Characteristic	Participants' sample (*n* = 112)	Employees of KU Leuven (2009) (*n* = 9280)
Age-related characteristics		
Mean age (number of years)	40.8 ± 13.8	36.8
Proportion of individuals aged < 40 years (%)	48.4	64.5
Proportion of individuals aged between 25 and 30 years (%)	16.7	28.1
Male (%)	51.6	53.9
Function at KU Leuven (%)		
(Emeritus) professor	27.7	15.7
Research assistant	42.0	52.9
Technical employee	30.4	32.9

Note. Participants of the study who were not employed at the KU Leuven (*n* = 14; e.g., partner of employee) were excluded.

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CHAPTER 2.2

Year-round effectiveness of physical activity counseling on subjective well-being: A self-determination approach among Flemish sedentary adults

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Abstract

This study evaluated the year-round effectiveness of need-supportive physical activity counseling on various dimensions of subjective well-being. Flemish adults who did not attain the recommended level of physical activity were assigned to an intervention (*n* = 92) or a control condition (*n* = 34). Participants of the intervention condition received a four-month physical activity coaching based on the Self-Determination Theory. The coaching was limited to five individual contact moments with a bachelor in Kinesiology specializing in health-related physical activity counseling. Self-reports on various intensities of physical activity and on physical and psychological well-being were completed before (i.e. pre-test), immediately after (i.e. post-test) and one year after (i.e. follow-up-test) the intervention. Repeated measurements ANOVAs showed significant time by condition interaction effects with respect to physical well-being. More specifically, physical well-being significantly increased in the intervention condition from pre- to post-test and from pre- to follow-up-test whereas no changes occurred in the control condition. Bootstrapping mediation analyses revealed that the changes in physical well-being were mediated by changes in strenuous intensity physical activity. The findings demonstrate the year-round effectiveness of need-supportive physical activity counseling with a limited number of contact moments on (physical) well-being and suggest its potential as a public health initiative.

Keywords: longitudinal intervention, well-being, physical activity, Self-Determination Theory

Introduction

According to the World Health Organization (2009), individuals should experience a sufficiently high level of well-being in order to realize their full potential, work productively and contribute to the community. Consequently, worldwide efforts have been made to improve and ensure the population's well-being. Well-being reflects an individual's life satisfaction and can be defined as the cognitive and affective evaluation of one's life (Diener et al., 2002). The concept of well-being is closely related to the concept of quality of life, which refers to the degree to which individuals judge the overall quality of their life in a favorable way (Fox, 1999; Grace and Ji-Hyun, 2008; Rejeski and Mihalko, 2001). More specifically, it involves individuals' perception of their current position in life in relation to their goals and expectations (Pristed et al., 2012; Sirgy, 2001). Well-being and quality of life are broad ranging concepts and should be considered as multidimensional, including both individuals' physical health and their psychological state (e.g., Lampinen et al., 2006; McAuley and Rudolf, 1995; Pristed et al., 2012; Stathi et al., 2002;World Health Organization, 1997).

Different dimensions of well-being and quality of life have been shown to be substantially improved by regular physical activity (PA) (e.g., Biddle and Mutrie, 2008; Fox, 1999; Ku et al., 2007; Mesquita et al., 2011; Penedo and Dahn, 2005; Rejeski and Mihalko, 2001). Moreover, higher intensity levels of PA yield larger improvements in both aerobic fitness and psychological well-being compared with lower intensity PA (e.g., Norris et al., 1992; Swain and Franklin, 2006). Despite the well-established positive influences of PA on well-being, the majority of the Western population does not attain the recommended levels of 30 minutes of moderate intensity PA on five days a week or 20 minutes of vigorous intensity PA three times a week (Varo et al., 2003). In order to affect well-being and quality of life at community level, (higher intensity) PA promotion should thus be considered as one of the major public health challenges.

Numerous studies have already demonstrated increased PA by implementing lifestyle interventions in which PA is integrated into one's daily life (e.g., Dunn et al., 1998; Foster et al., 2005; Opdenacker et al., 2008a). Among the overall reported positive results, theory-based health promoting strategies have been found to be most effective (Glanz and Bishop, 2010; McAuley and Rudolf, 1995). In this respect, the Self-Determination Theory (SDT) can be considered as a promising theoretical foundation for (long-term) health behavior changes such as PA (Ryan and Deci, 2000).

SDT-based interventions aim at enhancing self-determined, i.e. self-initiated and volitional, forms of motivation because these motivational regulations are associated with a more positive attitude towards PA and with sustained PA engagement (e.g., Fortier et al., 2011; Van Hoecke et al., 2012). According to SDT, self-determined PA can be facilitated by supporting the three basic psychological needs, i.e. the need for autonomy, the need for competence and the need for relatedness (Deci and Ryan, 1985). The need for autonomy refers to the experience of one's choice in and ownership of a given behavior; The need for competence implies the pursuit of experiencing mastery and success; The need for relatedness involves the experience of supportive relationships and the reciprocal concern for meaningful others.

Motivational interviewing (Markland and Vansteenkiste, 2007; Miller and Rollnick, 2002) has been identified as an appropriate collaborative counseling technique to facilitate the satisfaction of these three needs and hence to pursue self-determined PA. More specifically, applying the principles of motivational interviewing is assumed to strengthen individuals' self-determined motivation to attain a specific goal by helping them to explore and resolve their ambivalence within an atmosphere of acceptance (Miller and Rollnick, 2002).

Previous research has provided evidence that PA programs that support the needs for autonomy, competence and relatedness yield self-determined forms of motivation, and accordingly result in long-term engagement in, particularly higher intensity, PA (e.g., Teixeira et al., 2012; Van Hoecke et al., 2012). For example, a five-week school-based intervention demonstrated stronger intentions and higher participation rates in leisure-time PA among pupils who were taught by autonomy-supportive teachers compared with pupils who were taught by non-autonomy-supportive teachers (Chatzisarantis and Hagger, 2009). Similarly, Wilson et al. (2005) showed that adolescents who were involved in a four-week intervention based on SDT significantly increased in moderate and vigorous intensity PA whereas no changes were found in a comparison group receiving general health education. Within the health care context, Fortier et al. (2007) concluded that patients receiving brief and intensive autonomy-supportive counseling showed higher levels of perceived autonomy support and self-determined motivation at six weeks and higher PA levels at 13 weeks compared with patients receiving only brief counseling from their health care provider.

In addition to studying the effectiveness of (need-supportive) PA programs, understanding the motivational processes leading to sustained PA behavior can be beneficial in the development of effective PA promoting strategies. Accordingly, several SDT-grounded studies have tested the mediating influences of motivational regulations and perceived need-support on behavioral changes (Fortier et al., 2012; Teixeira et al., 2012). In this respect, self-determined motivation and perceived competence have been shown to significantly predict PA among patients receiving autonomy-supportive counseling (Fortier et al., 2007). Similarly, Silva et al. (2010a) demonstrated a positive influence of self-determined motivation on moderate and strenuous PA at 12 and 24 months among overweight women who were involved in a year-round need-supportive program.

Besides the demonstrated enhancement of self-determined (PA) behavior, the satisfaction of the three needs is assumed to be essential to experience an ongoing sense of integrity and well-being across individuals' lifespan (Ryan and Deci, 2000; Vansteenkiste et al., 2010). More specifically, individuals who perceive support for autonomy, competence and relatedness are expected to have higher levels of vitality, self-esteem, energy, mental health, cognitive functioning and positive affection (Deci and Vansteenkiste, 2004).

The positive influence of perceived need-support on well-being is presumed to be universal, and thus valid across time, populations and cultures. However, the degree to which perceived need-support yield improvements in health and well-being varies between individuals in that it depends on the attainment of one's personal goals. More specifically, need-satisfaction will only enhance well-being within

a context that is central to the individual's life such as work or leisure time (Ryan and Deci, 2000). In addition to the variation of well-being between individuals (i.e. according to the attainment of one's personal goals), the level of well-being can fluctuate within an individual (i.e. according to the degree to which one feels more autonomous, competent and related to others during his / her daily activities). In this respect, individuals' psychological functioning, well-being and emotions such as mood, vitality and self-esteem can fluctuate every day as a result of the variations in their experienced need-support (Gagné, 2003; Reis et al., 2000).

As mentioned above, increased PA levels on the one hand and perceived need-support on the other hand have been related to improved subjective health and well-being. Nevertheless, need-supportive interventions that aim to promote PA within a population have mainly focused on the effects on PA but have rarely examined the effects on well-being (e.g., Lloyd and Little, 2010; Teixeira et al., 2012). The few studies that did examine the effects on well-being emphasized the emotional component of well-being but ignored its physical and psychological dimensions (Reis et al., 2000; Vansteenkiste et al., 2010).

Given the theoretical assumptions of SDT, a need-supportive intervention might produce improved levels of subjective health through individuals' attainment of their goals. More specifically, it is assumed that the provision of need-support should be harmonized with one's specific goals, interests and daily activities in order to increase his / her level of well-being (Reis et al., 2000; Ryan and Deci, 2000). Consequently, in a population aiming to increase their PA level, a need-supportive PA counseling might enhance their level of well-being through (the attainment of their) PA (goals). Nevertheless, to our knowledge, previous research on need-supportive PA counseling has examined neither the effects on various dimensions of well-being nor the mediating influence of PA on well-being.

A second limitation with respect to research on subjective health is related to the study design. Most study designs on the association between PA and well-being have been cross-sectional, which does not allow the identification of causal relationships (Lampinen et al., 2006). Third, research on the various dimensions of subjective well-being has usually been qualitative (e.g., Ku et al., 2007; Stathi et al., 2002). The few quantitative studies that did focus on the effectiveness of a PA intervention on the different dimensions of well-being (Opdenacker et al., 2008b; Penedo and Dahn, 2005) involved short-term follow-up periods and did not consider various intensities of PA.

Taking the abovementioned limitations into account, we set up a longitudinal design with a sufficiently long follow-up period that would allow us to draw conclusions with respect to the long-term causality or direction of the associations between perceived need-support, PA and the different dimensions of well-being. More specifically, this study aimed at (1) determining whether SDT-based PA counseling enhances (long-term) physical and psychological well-being among adults who did not attain the recommended PA level for health before the beginning of the intervention but aimed to engage in PA regularly; and (2) establishing whether various intensities of PA mediate these intervention effects on well-being. It was hypothesized that physical and psychological well-being would increase in the intervention condition (INTERV) whereas no changes would occur in the control condition (CONTR). Additionally,

intervention effects on well-being were expected to be mediated by (higher intensity) PA because (1) need-supportive programs have been shown to be effective in increasing (in particular higher intensity) PA, (2) PA has been found to enhance subjective well-being, and (3) providing need-support with respect to individuals' personal goals is assumed to improve their well-being.

Methods

Recruitment and participants

Recruitment procedure

Participants were employees of the KU Leuven (e.g., research assistants, technical workers) who did not attain the recommended level of PA for health as prescribed by the American College of Sports Medicine (Haskell et al., 2007) and who were willing to engage in a four-month PA counseling provided by bachelors in Kinesiology (i.e. participants' coach during the intervention). Recruitment occurred through a personal email and an announcement in a weekly internal newsletter. The email and announcement were entitled 'Searching for a personal PA coach?' and included information on the different aspects of the counseling procedure and on the profile of employees that were allowed to participate in the program (i.e. those who were not regularly engaged in PA but who were willing to incorporate more PA in their daily routines). Although the recruitment took place in a work setting, participation in the PA intervention occurred independently of this setting.

Because of the large response rate on the abovementioned announcements, a personal email was sent to each of the volunteers (n = 382) in which they were requested to specify their weekly PA pattern. In particular, they were asked to complete a weekly schedule (i.e. time table) on which they had to provide details on the type, duration, intensity, frequency and time frame of the different PA they performed during a typical week. The completion of the weekly schedule was not a part of the pre-test measurements and was only used to have a general view on the volunteers' PA pattern before their participation in the program. The volunteers that already attained the recommended level of PA as prescribed by Haskell et al. (2007) were not considered as sedentary and were therefore excluded from the study (n = 36) (Figure 1). Furthermore, each coach (n = 30) was able to provide PA support to three participants. Consequently, the 'first come - first served' principle was applied, meaning that only first responders (n = 90) were allowed to participate in the PA intervention. Two participants dropped out shortly after the beginning of the study due to health motives and were replaced immediately, which resulted in 92 participants in INTERV.

Considering their interest and willingness to engage in regular PA, the remaining volunteers (n = 254), i.e. those who did not attain the recommended PA level but who responded too late (relatively to the first responders) to be included in INTERV, received a booklet with practical information of the different PA opportunities organized by the sports center of the university such as aerobic classes, fitness, swimming, badminton, marked walking routes in the environment etc. Moreover, they were given priority to participate in the PA counseling program during the following academic year on condition that they

completed PA-related questionnaires twice during the next four months, i.e. at pre-test and post-test measurements. In this respect, they would be included in a waiting-list CONTR. In total, 34 employees decided to participate in CONTR.

Dropout

At post-test (i.e. immediately after the intervention), dropout rates in INTERV and CONTR were 6.5% and 0.0% (χ^2 = 2.261, p = .152), respectively. Dropout rates at follow-up-test (i.e. one year after the intervention) compared with pre-tests were respectively 13.0% and 11.8% (χ^2 = 0.019, p = .580). A lack of motivation was the most frequently reported reason for dropping out. Demographic variables, well-being and PA did not significantly differ between dropouts and non-dropouts in INTERV and CONTR, indicating a non-selective study dropout with respect to these variables.

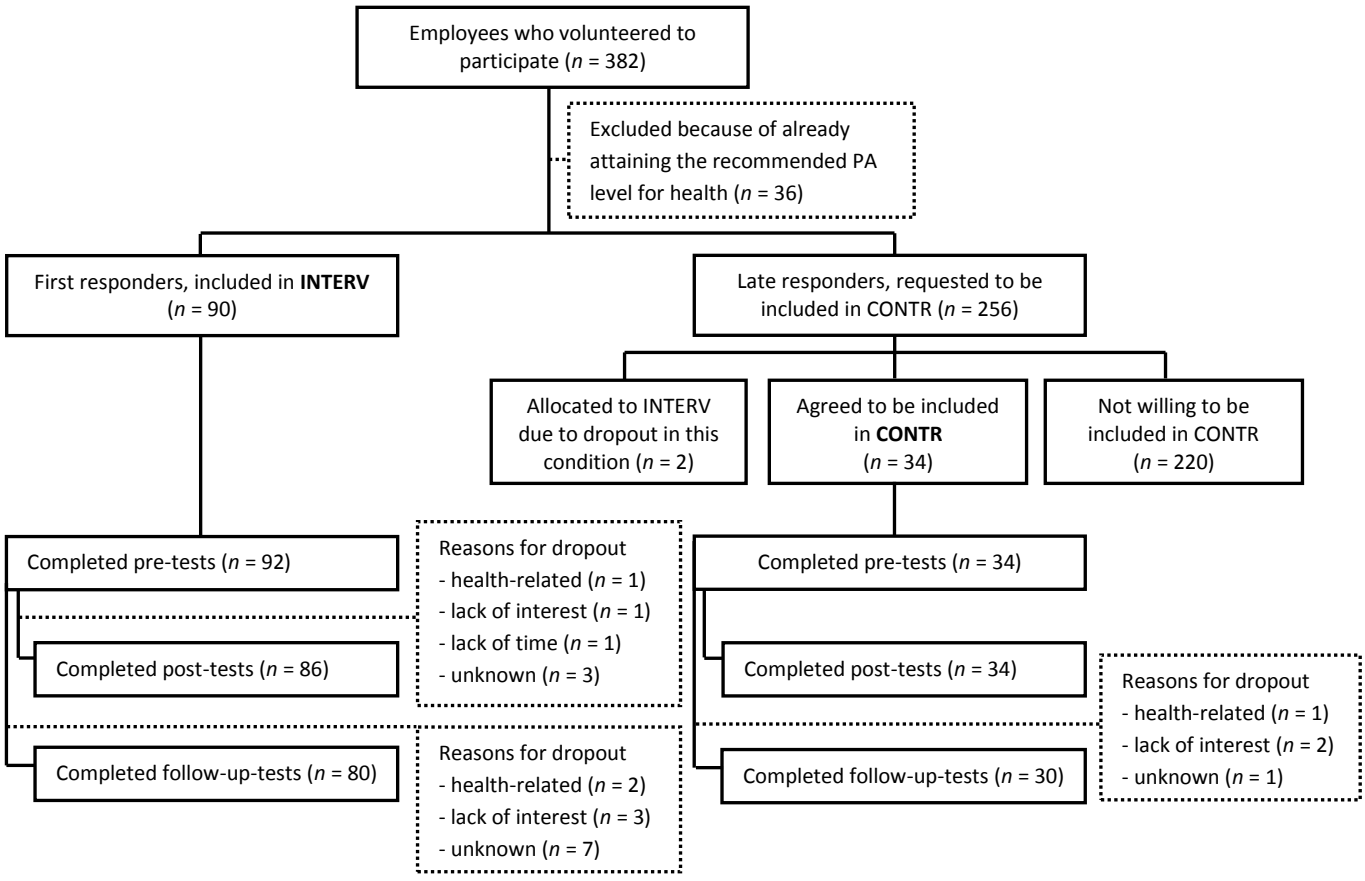

Figure 1. Flow chart of the study. PA, physical activity; INTERV, intervention condition; CONTR, control condition.

Procedures and intervention

PA coaches

Coaches were bachelors in Kinesiology specializing in health-related PA counseling. During an eight-hour course in psychology of behavioral motivation and PA promotion, the theoretical background of behavior change and need-supportive counseling was studied in depth. In addition to mastering the theory, the students improved their coaching proficiency by role playing, in which they learned to translate the theoretical principles into real-life situations. The student-coaches were especially trained in PA counseling according to SDT, motivational interviewing and applying behavioral change techniques. During the course, they received individual feedback, tips and tricks from their professor in exercise and sport psychology and from Health Fitness Specialists (MSc) who were experienced in need-supportive counseling.

Prior to the PA counseling, i.e. at the end of the course, the students were tested on their theoretical knowledge and their ability to apply the theory in a practical situation. An additional evaluation was planned immediately after the first contact moment between coach and client in order to discuss difficulties, to clear up ambiguities and to deal with problems instantaneously. During the counseling period, the student-coaches were encouraged to make use of an online forum on which they could share their experiences with, and announce difficulties, ask questions and provide useful information to other students. By informing the professor and reflecting on the progress of their counseling after each contact moment with their client, the student-coaches were supervised thoroughly and problems could be solved immediately.

Counseling procedure

After recruitment, five individual contact moments occurred between coach and participants of INTERV. The amount of time between the different contact moments varied from three weeks at the beginning of the PA counseling to five weeks at the end of the PA counseling.

During a one-hour face-to-face intake session, participants of INTERV formulated several PA goals taking into account their PA history, preferences and abilities. The coach supported the client to set up a realistic and appropriate PA plan. For example, engaging in PA in which individuals' body is carried such as cycling might have been an appropriate PA for participants who were overweight; Engaging in PA in which individuals have to play against opponents such as badminton or volleyball might have been appropriate for participants who were involved in team sports in their childhood. In this respect, the coach explored PA options in collaboration with the client. However, in the end, the client decided him / herself which type, frequency and intensity of PA he / she was willing to perform. Accordingly, the coach acted as a facilitator rather than a prescriber of PA. The goals, which were specified by PA type, location, time frame, company and possible barriers and solutions were written down in an individual weekly schedule. The main objective of the PA intervention was to support the participants to attain the recommended level of PA for health as prescribed by Haskell et al. (2007).

During the intake session, the coaches explicitly fostered the three basic psychological needs outlined by SDT, i.e. the need for autonomy, the need for competence and the need for relatedness. The need for autonomy refers to individuals' desire to be the origin of their own behavior, and accordingly involves a sense of choice, personal control and self-endorsement. The coach applied the following strategies to satisfy participants' need for autonomy: focusing on task-oriented rather than ego-oriented goals, encouraging individuals to initiate actions for their own reasons, minimizing pressure by using autonomy-supportive language (e.g., pronouncing 'may' instead of 'must'), acknowledging individuals' perspective, providing informational feedback and a meaningful rationale for given advice, and using client-centered strategies such as exploring options. The need for competence, which implies individuals' pursuit of experiencing mastery and success within a challenging environment, was fulfilled by providing structure, helping individuals to develop clear expectations, formulating challenging but realistic goals in collaboration with the individual, identifying barriers and drafting a plan to solve them, pronouncing positive feedback and reinforcing self-motivational statements. Finally, the PA coaches supported participants' need to interact with, to be related and connected to, and to feel a sense of belongingness for other individuals by demonstrating understanding, showing unconditional regard, using non-judgmental and positive language, and creating an empathetic, warm and positive atmosphere (e.g., by active listening).

In addition to the need-supportive counseling, the coaches applied the following three behavior change techniques: planning (i.e. helping the participants to fit the PA goals in their daily schedule), barrier identification (i.e. identifying PA barriers and planning ways to overcome them) and suggesting prompts and cues (i.e. teaching the participants to identify environmental cues that can be used to remind them to perform PA) (Abraham and Michie, 2008).

After the intake session, three follow-up contacts took place in which participants were supported through face-to-face contacts, booster phone calls or email conversations. Given that each of these methods have been shown to be effective in changing individuals' behavior (Opdenacker and Boen, 2008; Portnoy et al., 2008), the way in which participants were contacted was in line with their preferences. During the follow-up contacts, the coaches motivated the participants to persist in their PA, relying on SDT-based coaching and motivational interviewing. Moreover, adherence was evaluated, PA goals were modified if necessary and participants were praised for their effort and performance.

One face-to-face outtake session was scheduled to evaluate the participants' behavioral change, to make sure the participants mastered the required techniques to continue their PA engagement after the intervention and to discuss future challenges. After the outtake session, there was no contact anymore between coach and participant. Moreover, participants were not informed on the occurrence of year-round follow-up-test measurements until one year after pre-tests. More specifically, at this moment, they were sent a letter in which they were asked to complete the follow-up-test questionnaires in order to provide information on their current PA pattern and well-being.

Participants of INTERV completed measurements at pre-test (i.e. at the beginning of the intake session), at post-test (i.e. at the beginning of the outtake session) and at follow-up-test (i.e. one year after

the beginning of the intervention) under the supervision of their coach. Participants of CONTR did not receive any PA instruction or counseling. They completed pre-, post- and follow-up-tests in the same time period as INTERV and under the supervision of a Health Fitness Specialist (MSc). The study was approved by the Ethical Committee of the university.

Measurements

Well-being

Various dimensions of subjective well-being were measured by the Leuven Well-Being Scale from Marcoen et al. (2002). Consistent with previous research on subjective health among Flemish adults (Opdenacker et al., 2008b; Raepsaet et al., 2010) and considering the close association between PA on the one hand and physical and mental health on the other hand, only the physical and psychological dimensions of well-being were evaluated in this health-oriented intervention. Four items were selected out of the physical well-being subscale and four items were selected out of the psychological well-being subscale. This selection was based on factor loadings and internal consistency scores (Opdenacker et al., 2008b). Physical well-being asks for individuals' physical health as well as for the happiness and acceptance of their body (e.g., 'I am satisfied with my body'). Psychological well-being refers to individuals' satisfaction with themselves and their life (e.g., 'I am happy with the person I am'). Participants indicated how frequently they agreed with the given statement on a seven-point Likert scale, ranging from '1 = never' to '7 = always'. Cronbach's alpha coefficients for pre-, post- and follow-up-tests ranged from .67 to .84, indicating good to very good internal consistency.

PA

PA was assessed with a modified version of the Godin Leisure-Time Exercise Questionnaire (GLTEQ) (Godin and Shephard, 1985). This brief questionnaire is considered to be clearly comprehensible and has frequently been employed in Western populations (e.g., De Bacquer et al., 2010; Edmunds et al., 2006). Participants were asked for the number of times they engaged for at least 20 minutes in mild, moderate and strenuous intensity PA in a typical week during the past month. The reported frequencies were weighted by metabolic equivalents for each intensity category, i.e. three, five and nine respectively, and summed to obtain an overall measure of PA. Adequate validity and test-retest reliability of GLTEQ have been demonstrated previously (Godin and Shephard, 1985; Jacobs et al., 1993).

The applied questionnaire differed from the original questionnaire with respect to the following two aspects: (1) Given that active transport such as walking and cycling is popular among the Flemish population, participants were asked for the number of times that they engaged in PA each week not only during their leisure time but also for transportation (Scheerder et al., 2011); and (2) In order to easily translate the reported frequencies on the GLTEQ to the recommended PA level for health as prescribed by Haskell et al. (2007), participants were asked for the number of times that they engaged in PA each week for 20 minutes or more instead of 15 minutes or more. According to Scheerder et al. (2011), an overall

score of 27 on GLTEQ corresponds with the recommended PA level of performing 20 minutes of strenuous PA on at least three days a week.

Perceived need-support of the coach

Participants' perceived need-support of the PA coach was measured by a modified version of the Teacher As Social Context Questionnaire (Belmont et al., 1988), which was originally developed to evaluate need-support within a school context. This questionnaire has been applied in previous research among Western populations (e.g., Sierens et al., 2009; Vansteenkiste et al., 2009) and assesses the three dimensions of coaches' behavior as proposed by SDT, i.e. autonomy support (eight items; e.g., 'My coach listens to my opinion and ideas'), competence support (eight items; e.g., 'My coach shows me how to solve problems for myself') and relatedness support (eight items; e.g., 'My coach really cares about me'). The questionnaire on perceived need-support was only completed after the intervention (i.e. at post-test) and by participants of INTERV. They were asked to indicate their agreement with the items on a five-point Likert scale, ranging from '1 = completely disagree' to '5 = completely agree'. Cronbach's alpha coefficients for autonomy support, competence support, relatedness support and perceived need-support in general were respectively .79, .85, .84 and .92, indicating very good internal consistency.

Data analysis

Data were analyzed using SPSS 16.0 (SPSS Inc, Chicago, IL, USA). Differences between INTERV and CONTR were assessed by one-way ANOVAs for continuous measures and chi-square tests (χ^2) for categorical measures. Intervention effects on well-being were conducted with repeated measurements ANOVAs. Indirect effects of the intervention on changes in well-being through changes in various intensities of PA in INTERV were tested by the bootstrapping procedure described by Preacher and Hayes (2008). This method does not make assumptions on the shape of sampling distribution of the indirect effect (Preacher and Hayes, 2008). Bias-corrected confidence intervals of the indirect effects were generated with 2000 resamples. In order to determine which intensity of PA was most successful in explaining variances in well-being, (change scores of) mild, moderate and strenuous PA were included simultaneously in a multiple mediator model. Mediation analyses were conducted in the short term (i.e. from pre- to post-test) and in the long term (i.e. from pre- to follow-up-test). One person was excluded from all analyses because the pre-test GLTE-score exceeded three standard deviations from the pre-test mean score. Significance level was set at $p < .05$.

Results

Demographic profile

Table 1 displays the demographic characteristics of the participants of INTERV and CONTR at pre-test. No significant differences emerged between both conditions for these variables.

Table 1 Means (SD) or percentages for demographic characteristics of INTERV and CONTR at pre-test.

Characteristic	INTERV (*n* = 92)	CONTR (*n* = 34)	*F* or χ^2	*p*
Age (years)	41.480	40.820	0.056	.813
	(13.335)	(14.655)		
Male (%)	52.2	50.0	0.047	.828
Married or living together with partner (%)	68.5	78.8	1.259	.186
Body mass index (kg/m²)	24.991	24.449	0.433	.512
	(4.238)	(3.528)		
Function at KU Leuven (%)			10.446	.064
Professor	19.6	24.2		
Research assistant	33.7	45.5		
Technical employee	30.4	18.2		
Emeritus professor	3.3	6.1		
Other (e.g., partner of employee)	13.0	6.1		

Note. SD, standard deviation; INTERV, intervention condition; CONTR, control condition.

Effects on well-being

INTERV and CONTR did not differ significantly with respect to physical and psychological well-being at pre-test (physical well-being: $F = 0.231$, $p = .632$; psychological well-being: $F = 0.112$, $p = .739$). However, significant 3 (time) × 2 (conditions) interaction effects on physical well-being indicated that both conditions changed differently over time (Table 2). A more detailed description of the changes in well-being in the short term (i.e. from pre- to post-test) and in the long term (i.e. from pre- to follow-up-test) is provided below.

From pre- to post-test

Physical well-being changed differently over time in INTERV and CONTR from pre- to post-test. More specifically, INTERV improved their level of physical well-being ($F = 57.113$, $p < .001$, $\eta^2 = .402$) whereas no changes emerged in CONTR ($F = 3.980$, $p = .055$, $\eta^2 = .111$). Consequently, higher post-test levels of physical well-being were found in INTERV compared with CONTR ($F = 7.238$, $p = .008$). Contrary to physical well-being, psychological well-being did not change significantly from pre- to post-test in INTERV or CONTR (INTERV: $F = 1.747$, $p = .190$, $\eta^2 = .120$; CONTR: $F = 0.396$, $p = .534$, $\eta^2 = .012$).

From pre- to follow-up-test

A borderline significant 2 (time) by 2 (conditions) interaction effect was found in physical well-being ($F = 3.341$, $p = .070$, $\eta^2 = .030$). More specifically, physical well-being significantly increased in INTERV ($F = 11.921$, $p = .001$, $\eta^2 = .131$) whereas no changes occurred in CONTR ($F = 0.001$, $p = .974$, $\eta^2 = .000$).

Consequently, INTERV showed significantly higher levels of physical well-being at follow-up-test compared with CONTR (F = 8.080, p = .005).

With respect to psychological well-being, a significant decrease was found in both conditions from pre- to follow-up-test (INTERV: F = 4.713, p = .033, η^2 = .056; CONTR: F = 6.543, p = .016, η^2 = .189). However, pre- to follow-up-test changes in psychological well-being were not significantly different between INTERV and CONTR (F = 1.357, p = .247, η^2 = .013). This indicates that, in the long term, psychological well-being was not affected by the PA intervention.

Table 2 Means (SD) at pre-test, post-test and follow-up-test for physical and psychological well-being in INTERV and CONTR, 3 (time) x 2 (conditions) interaction effects and 2 (time) x 2 (conditions) interaction effects from pre- to post-test and from pre- to follow-up-test.

		INTERV	CONTR	3 (time) x 2 (conditions) INTERACTION		2 (time) x 2 (conditions) INTERACTION	
		Mean (SD)	Mean (SD)	*F*	η^2	*F*	η^2
Physical WB	Pre	4.284 (0.886)	4.197 (0.910)	3.955 *	.037		
	Post	4.945 (0.827)	4.466 (0.972)			5.573 *	.045
	Fu	4.678 (0.678)	4.220 (0.905)			3.341 £	.030
Psychological WB	Pre	5.614 (0.676)	5.568 (0.683)	1.767	.017		
	Post	5.698 (0.730)	5.500 (0.650)			1.540	.013
	Fu	5.470 (0.784)	5.285 (0.755)			1.357	.013

Note. SD, standard deviation; INTERV, intervention condition; CONTR, control condition; WB, well-being; Pre, value of well-being at pre-test; Post, value of well-being at post-test; Fu, value of well-being at follow-up-test; 3 x 2 INTERACTION, interaction effect over time (3) and between conditions (2) for physical and psychological well-being; 2 x 2 INTERACTION, interaction effect over time (2; i.e. from pre- to post-test or from pre- to follow-up-test) and between conditions (2) for physical and psychological well-being; *, p < .05; £, p = .07.

Individuals' changes in well-being

Irrespective of the average degree to which INTERV and CONTR changed in well-being, one-way ANOVAs were conducted in order to examine whether individuals' tendency to improve or reduce their level of well-being was influenced by their initial level of well-being. It was shown that participants who improved their subjective well-being reported lower pre-test levels of well-being than participants who did not improve their level of well-being. This tendency was found for both dimensions of well-being, and in the short as well as in the long term (from pre- to post-test: physical well-being: F = 12.061, p = .001; psychological well-being: F = 5.024, p = .027; from pre- to follow-up-test: physical well-being: F = 31.376, p < .001; psychological well-being: F = 6.657, p = .011).

Mediation through PA

Table 3 displays the mediation effects of various intensities of PA on physical well-being in INTERV. Given that the intervention did not affect psychological well-being, mediation analyses were not conducted with respect to this dimension of subjective well-being.

Table 3 Mediation effects of changes in physical activity on changes in physical well-being.

	α-path coefficient (SE)	β-path coefficient (SE)	αβ-path coefficient (SE)	95% CI of αβ
Pre- to post-test				
Δprepo physical WB				
Δprepo mild PA	- 0.129 (0.499)	0.057 (0.029)	- 0.007 (0.032)	- 0.090 to 0.044
Δprepo moderate PA	- 1.201 (0.500) *	0.026 (0.030)	- 0.031 (0.035)	- 0.115 to 0.027
Δprepo strenuous PA	- 0.948 (0.251) ***	0.205 (0.060) ***	- 0.195 (0.071)	- 0.373 to - 0.087
Multiple mediator model			- 0.233 (0.088)	- 0.424 to - 0.076
Pre- to follow-up-test				
Δprefu physical WB				
Δprefu mild PA	- 1.066 (0.594)	0.043 (0.028)	- 0.046 (0.035)	- 0.149 to - 0.001
Δprefu moderate PA	- 1.080 (0.712)	0.027 (0.023)	- 0.030 (0.035)	- 0.136 to 0.013
Δprefu strenuous PA	- 0.701 (0.290) *	0.133 (0.057) *	- 0.093 (0.058)	- 0.247 to - 0.009
Multiple mediator model			- 0.169 (0.069)	- 0.325 to - 0.056

Note. WB, well-being; PA, physical activity; Δprepo, change score from pre- to post-test; Δprefu, change score from pre- to follow-up-test; α, estimate of the intervention effect on changes in the proposed mediators; β, estimate of the direct effect of changes in the proposed mediators on changes in well-being while controlling for the intervention effect; αβ, estimate of the indirect intervention effect on changes in well-being through the proposed mediators; 95% CI, 95% bias-corrected confidence interval with the empirically derived bootstrapped sampling distribution of αβ (result of 2000 bootstrap resamples); *, $p < .05$; **, $p < .01$, ***, $p < .001$.

From pre- to post-test

The significant α-paths indicate an intervention effect on pre- to post-test changes in moderate and strenuous PA. This means that INTERV increased more in moderate and strenuous PA from pre- to post-test than CONTR. The overall intervention effects on mild, moderate, strenuous and total PA are displayed in Table 4 and described in detail in Van Hoecke et al. (2012). Furthermore, significant direct effects from changes in strenuous PA to changes in physical well-being (β-paths) demonstrate that the more participants increased in strenuous PA from pre- to post-test, the more they increased in physical well-being from pre- to post-test. Finally, the confidence intervals of the indirect αβ-pathways via the proposed mediators (i.e. changes in mild, moderate and strenuous PA) indicate that pre- to post-test changes in strenuous PA contributed significantly to the pre- to post-test changes in physical well-being. The significant direct intervention effect on physical well-being became non-significant when controlling for the proposed

mediators, indicating full mediation. The overall multiple mediator model accounted for 16.1% (F = 5.545, p = .001) of the variance in pre- to post-test changes in physical well-being.

From pre- to follow-up-test

The mediating influence of PA on well-being in the long term was similar to the mediating influence in the short term. More specifically, a significant intervention effect on changes in strenuous PA (α-paths) and a significant β-path from changes in strenuous PA to changes in physical well-being were identified. Furthermore, pre- to follow-up-test changes in strenuous PA contributed to the indirect intervention effect on pre-to follow-up-test changes in physical well-being (αβ-paths). In addition to the similarities with the pre- to post-test results, pre- to follow-up-test changes in mild PA significantly contributed to the intervention effect on pre- to follow-up-test changes in physical well-being. The multiple mediator model with pre- to follow-up-test changes in mild, moderate and strenuous PA as proposed mediators explained 11.2% (F = 3.273, p = .014) of the variance in pre- to follow-up-test changes in physical well-being.

Table 4 Means (SD) at pre-test, post-test and follow-up-test for mild, moderate and strenuous physical activity in INTERV and CONTR, 3 (time) x 2 (conditions) interaction effects and 2 (time) x 2 (conditions) interaction effects from pre- to post-test and from pre- to follow-up-test.

		INTERV	CONTR	3 (time) x 2 (conditions) INTERACTION		2 (time) x 2 (conditions) INTERACTION	
		Mean (SD)	Mean (SD)	F	η^2	F	η^2
Mild PA	Pre	1.007 (1.752)	1.345 (1.738)	1.952	.018		
(times a week for	Post	1.214 (2.332)	1.448 (2.422)			0.067	.001
≥ 20 minutes)	Fu	1.831 (2.380)	1.103 (1.566)			3.228	.029
Moderate PA	Pre	0.916 (1.635)	1.379 (1.374)	2.122	.020		
(times a week for	Post	2.370 (2.751)	1.767 (2.009)			5.765 *	.047
≥ 20 minutes)	Fu	2.896 (3.336)	2.155 (3.410)			2.302	.021
Strenuous PA	Pre	0.224 (0.558)	0.655 (1.045)	5.882 **	.054		
(times a week for	Post	1.175 (1.248)	0.647 (0.930)			14.291 ***	.109
≥ 20 minutes)	Fu	1.065 (1.306)	0.776 (0.960)			5.852 *	.052
Total PA	Pre	9.614 (9.579)	16.828 (12.723)	8.998 ***	.080		
(GLTE-score)	Post	26.071 (14.788)	19.000 (15.695)			23.277 ***	.166
	Fu	29.558 (20.896)	21.069 (21.570)			9.849 **	.084

PA, physical activity; INTERV, intervention condition; CONTR, control condition; GLTE-score, PA score obtained by the Godin Leisure-Time Exercise Questionnaire; SD, standard deviation; Pre, pre-test value; Post, post-test value; Fu, follow-up-test value; 3 x 2 INTERACTION, interaction effect over time (3) and between conditions (2) for mild, moderate, strenuous and total physical activity; 2 x 2 INTERACTION, interaction effect over time (2; i.e. from pre- to post-test or from pre- to follow-up-test) and between conditions (2) for mild, moderate, strenuous and total physical activity; *, p < .05; **, p < .01; ***, p < .001.

The recommended PA level and well-being

Because of the mediating influence of (strenuous) PA on well-being, one-way ANOVAs were conducted in order to examine the relation between attaining the recommended PA level for health and participants' level of and improvement in subjective well-being. More specifically, it was tested whether high levels of well-being corresponded with an overall score of 27 on GLTEQ, and thus with the PA health recommendation as prescribed by Haskell et al. (2007), i.e. performing 20 minutes of strenuous PA three times a week. It was shown that participants who attained a GLTE-score of at least 27 perceived higher levels of physical well-being compared with those who did not attain a GLTE-score of 27 (F = 5.913, p = .017). Moreover, participants who attained the recommended PA level at follow-up-test (i.e. scored 27 or more on the GLTEQ) were also those who improved their level of physical well-being from pre- to follow-up-test (χ^2 = 6.780, p = .008).

Perceived need-support

After the intervention, participants of INTERV indicated a mean score of 4.422 ± 0.388 on a five-point Likert scale for perceived need-support in general. With respect to the different dimensions of need-support, the following mean scores were found: 4.540 ± 0.384 for autonomy support, 4.438 ± 0.446 for competence support and 4.287 ± 0.509 for relatedness support. Subsequent analyses indicated a minimum score of 3.380 on perceived need-support, with 87.0% of the participants scoring four or more on a five-point Likert scale with respect to perceived need-support.

Discussion

The results of this study demonstrated the effectiveness of a four-month need-supportive PA counseling on the physical dimension of subjective well-being. More specifically, INTERV showed significant increases in physical well-being whereas no changes occurred in CONTR. The improvement in well-being after the intervention is consistent with literature on the effectiveness of various PA programs on physical health and well-being (e.g., Anderson et al., 2005; Lloyd and Little, 2010; Opdenacker and Boen, 2008; Wilson et al., 2003). At the same time, the positive influence on the physical component of well-being in the long term is remarkable given that studies examining sustained PA effects on subjective health and well-being produced rather inconsistent results (e.g., DiLorenzo et al., 1999; Fox et al., 2007; Hicks et al., 2003; McAuley and Rudolf, 1995).

Besides showing the long-term effectiveness of a PA program on well-being, this study extended previous research by demonstrating the effectiveness of a PA program that is need-supportive on well-being. In particular, results indicated that sedentary adults who aimed to increase their PA level obtained positive changes in physical well-being due to a PA counseling in which the three basic psychological needs were fostered. In this respect, it is suggested that the perception of physical well-being among individuals who are motivated to engage in PA can be improved by a PA coach who (1) supports individuals' need for autonomy by providing personal control on their PA goals, minimizing pressure and pronouncing a

meaningful rationale for given advice, (2) supports individuals' need for competence by formulating a structured and appropriate PA plan, drafting solutions for identified PA barriers and giving positive feedback, and (3) supports individuals' need for relatedness by creating a meaningful and interpersonal relationship within an empathetic environment.

The need-supportive character of the PA intervention is demonstrated by the relatively high scores on the different dimensions of perceived need-support at post-test, i.e. 4.287 or more on a five-point Likert scale. However, in addition to the need-supportive character of the counseling procedure, the following two aspects might have contributed to these high rates on need-support in INTERV: (1) The application of the 'first come - first served' principle. Given that only a limited number of volunteers were allowed to participate in the PA program, the participants might have been grateful and pleased they got the chance to be counseled by a bachelor (i.e. an expert) in Kinesiology. In this respect, every encouraging contact during the counseling procedure was probably experienced positively and as need-supportive, especially given that the participants were highly motivated to increase their PA level; (2) The PA counseling as a part of the educational curriculum of the bachelors in Kinesiology. The educational purpose of the need-supportive PA counseling, which also entails that the counseling was free of charge, might have led the participants to be cooperative towards the student-coaches and to evaluate them rather positively. However, even though the scores on perceived need-support might have been to some extent overestimated, the sustained improvements in physical well-being one year after the intervention demonstrate the positive influence of the need-supportive PA counseling on well-being. Moreover, the demonstrated improvements in the long term strengthen the contribution of the SDT-based counseling to the increases in subjective health relative to possible participation effects.

In addition to examining the effects of a need-supportive PA program on subjective well-being, we evaluated the mediating influence of various intensities of PA. As hypothesized, pre- to post-test and pre- to follow-up-test changes in (higher intensity) PA contributed to changes in (physical) well-being in INTERV. These results are consistent with SDT-based assumptions and suggest that providing need-support with respect to the pursuit and attainment of one's personal goals enhances the person's well-being (Ryan and Deci, 2000). The finding that mainly strenuous PA contributed to the intervention effects on well-being highlights the importance of differentiating between various intensities of PA. The role of higher intensity PA on improving well-being can be explained by two processes: (1) A cognitive process. Higher intensity PA is considered to be more purposeful and structured than mild PA (e.g., aerobic classes versus active transportation, respectively). Consequently, the higher the intensity of performed PA, the higher the required level of cognitive processing (Edmunds et al., 2006; Silva et al., 2010b). Given that the intervention involved a theoretically-grounded need-supportive PA counseling procedure, and thus required a sufficient level of cognitive functioning, mainly higher intensity PA increased in INTERV (Van Hoecke et al., 2012); (2) A physiological process. The causal relationship between changes in strenuous PA and changes in physical well-being points out that the higher the intensity of PA in which people are participating, the more they are susceptible to perceive the positive outcomes of their PA engagement on the physical dimension of

well-being. This finding is in line with previous research and indicates that higher intensity PA is more beneficial to improve physical fitness, health and well-being than lower intensity PA (e.g., Norris et al., 1992; Swain and Franklin, 2006). Physical fitness and health are both considered to be important elements of the physical component of well-being and quality of life (Pristed et al., 2012; Stathi et al., 2002; Thogersen-Ntoumani et al., 2005). Accordingly, it appears that the sustained effects on physical well-being in the long term can be explained by the long-term effects on strenuous PA. Specifically, as long as one succeeds in persisting in high intensity PA, improved feelings of physical fitness, and thus higher levels of physical well-being, will be maintained. The close association between higher intensity PA and physical well-being is also confirmed by subsequent analyses pointing out that participants who increased their higher intensity PA were also those who increased their level of physical well-being.

From pre- to follow-up-test, the need-supportive PA counseling procedure yielded increases in physical well-being not only through increases in strenuous PA but also through increases in mild PA. This means that, in the long term, mild PA contributed to the variance in well-being as well. The integration of low intensity PA (e.g., active transportation) in participants' daily life might have resulted from their increases in higher intensity PA. More specifically, the more participants engage in higher intensity PA (e.g., dance classes), the more they improve their physical fitness and the less effort engagement in low intensity PA requires. Moreover, the contribution of mild PA to well-being suggests that, in the long term, low intensity and thus habitual PA was perceived as self-determined as well.

Overall, the results of this intervention suggest that it is important for individuals to increase their high intensity PA level, for coaches to facilitate individuals' needs for autonomy, competence and relatedness with respect to their PA goals and for policy makers to support SDT-based PA interventions in order to obtain subjective health benefits in the population. In particular, individuals and policy makers should be informed on the importance of attaining the recommended level of PA for health as prescribed by Haskell et al. (2007) in order to improve individuals' perception of physical well-being.

The strong association between physical well-being and PA also emphasizes the broad ranging character of physical well-being in that it involves more than avoiding diseases and disabilities (Reis et al., 2000; Stathi et al., 2002). It refers to the satisfaction with one's body, the ability to perform habitual tasks without effort and the experience of a good health, a sufficient physical fitness and satisfactory feelings of perceived vitality (Ku et al., 2007; Stathi et al., 2002). Those physical aspects of well-being are probably perceived shortly after one has increased his / her (high intensity) PA level. This reasoning is in accordance with previous research (Rejeski et al., 2001; Stathi et al., 2002) in which it was stated that functional changes are the most direct and salient effects experienced through involvement in PA programs.

At the same time, the findings underline the multidimensional character of well-being. Previous studies have established the key role of PA in enhancing mental health, perceiving higher levels of happiness and obtaining a feel-good effect (e.g., DiLorenzo et al., 1999; Fox, 1999; Opdenacker et al., 2008b; Stathi et al., 2002). However, in contrast with our hypotheses and despite the well-pronounced improvements in physical well-being, no intervention effects emerged on the psychological component of

well-being. The lack of positive changes in psychological well-being can be explained by two reasons. First, the relatively high baseline score of psychological well-being, i.e. 5.6 on a seven-point Likert scale, suggests that the participants were initially already happy and satisfied with their lives. Consequently, further improvements in psychological well-being were less likely to occur than in physical well-being, which had a substantially lower score at baseline, i.e. 4.2 on a seven-point Likert scale. Given that participants were employees, the high level of psychological well-being is in accordance with Keyes and Waterman (2003) who recognized employment as a determinant of subjective well-being, happiness and mental health. Second, there is a clear difference in meaning between the items of the physical well-being subscale and the items of the psychological well-being subscale. More specifically, the items of the physical well-being subscale refer to individuals' physical health, body perception and physical fitness whereas the items of the psychological well-being subscale refer to how people feel 'in general'. Given the physical aspect of (high intensity) PA, participants were probably more likely to perceive positive changes in their physical well-being than in their psychological well-being. Even though the participants might have felt happy and psychologically satisfied when attaining their PA goals, other factors than the pursuit of their PA goals might have been crucial to yield positive changes in their psychological well-being and quality of life (e.g., social reasons, enjoyment, work-related aspects).

Nevertheless, as assumed by SDT, the overall reported results point out the effectiveness of providing need-support in enhancing particular dimensions of subjective well-being through the pursuit and attainment of one's goals. Need-supportive PA counseling might therefore be considered as a promising health promoting strategy among sedentary adults who aim to increase their PA level. Furthermore, the results indicated that such an intervention is especially appropriate for individuals with initially lower levels of well-being. Interventions should thus focus mainly on this population segment in order to improve public health through PA promotion.

Before concluding, strengths and limitations should be noted. The use of a longitudinal design constitutes a first strength as it allowed us to examine causality between need-supportive counseling, PA and well-being rather than studying cross-sectional associations. Moreover, this study focused on the effectiveness in the long term, which is in line with SDT-based assumptions. Second, given that well-being is associated with PA on the one hand and with need-satisfaction on the other hand, mediation effects of PA on well-being were examined. This enabled us to gain insight in the extent to which increased PA contribute to improved well-being. Third, by acknowledging the physical and psychological components of subjective well-being, we were informed on the influence of PA on the different dimensions of well-being. Fourth, despite the individual character of the contact between coach and participant, the limited number of contact moments facilitates the implementation of such a PA intervention at community level. Moreover, the potential to implement this health promoting program at a large scale is supported by the number of coaches applied in this study (n = 30) as well as by the relatively condense course that was provided to them in order to obtain satisfactory coaching proficiencies with respect to SDT and motivational interviewing.

Fifth, the inclusion of CONTR strengthens the positive effects of the need-supportive PA intervention on subjective well-being.

At the same time, the recruitment of CONTR constitutes the main limitation. Due to ethical, educational and social reasons, the 'first come - first served' principle was applied. This recruitment procedure entails the lack of a strict randomization between INTERV and CONTR. Nevertheless, no significant baseline differences were identified between both conditions with respect to demographic variables, well-being, motivation to PA engagement and low to moderate intensity PA. Moreover, given that 94% of the volunteers responded within 24 hours after the time the announcements were made, no bias concerning assignment to INTERV and CONTR was assumed by applying the 'first come - first served' principle.

The volitional character of participation can be considered as a second limitation. The sample consisted of adults motivated to increase their PA level, which might have contributed to the positive effects of the counseling. This self-selection process hampers the generalizability of the findings to a less motivated population. Furthermore, the probably high motivation of all initial volunteers to increase their PA may also have led to the unequal number of participants in INTERV and CONTR. The majority of the volunteers responded to the announcement within one day, which reflects their willingness to be counseled in their PA. Accordingly, the volunteers who were not included in INTERV because of their late reply relatively to the first responders, were probably willing to engage in PA immediately and thus to make use of other PA opportunities than the PA counseling.

Third, PA measurements were based on self-reports. This may have led the participants to overestimate their PA level, to inaccurately interpret some of the questionnaires or to produce social desirable answers. However, subjective measures of health have been shown to be more strongly related to outcomes such as life satisfaction than are objective health indices (Rejeski and Mihalko, 2001).

Fourth, the use of a modified and shortened version of the Leuven Well-Being Scale of Marcoen et al. (2002) reduces the generalizability of the results to other dimensions of well-being and to subjective well-being in general. However, the main purpose of this intervention was to improve individuals' health and well-being through an increase of their PA level. Given that PA is closely related to physical and mental health, only the physical and psychological dimensions of subjective well-being were evaluated.

Fifth, applying 30 counselors may have increased the variety with respect to the PA counseling, and consequently may have reduced the coaching consistency among the coaches. However, the students were educated and instructed sufficiently, were supported by experienced Health Fitness Specialists (MSc) and received feedback from their professor and other student-coaches. Accordingly, the student-coaches were well prepared to fulfill their role as a need-supportive PA counselor appropriately and to provide high-quality coaching. Moreover, the relatively high score on perceived need-support after the intervention, i.e. 4.420 on a five-point Likert scale with a minimum score of 3.380, suggests that each of the student-coaches has provided PA counseling in a need-supportive and satisfactory way. Furthermore, the finding that a PA intervention applied by a large number of coaches (and thus with more room for interpretation of the

theoretical principles) yielded positive changes in the long term even strengthens the results of this study and enlarges the potential to implement such a health promoting program at a large scale.

In conclusion, the results partially supported our hypotheses and provide evidence for the year-round effectiveness of need-supportive PA counseling with a limited number of contact moments on improving physical well-being through strenuous PA. Accordingly, the promotion of high intensity PA through SDT-based coaching might be beneficial to increase well-being and quality of life at community level, especially among adults with initially lower levels of subjective well-being.

Endnote

The term 'sedentary' refers to 'not attaining the PA recommendations for health as prescribed by Haskell et al. (2007)', i.e. in addition to performing daily activities that last less than ten minutes or that are of mild intensity, accumulating at least moderate intensity aerobic PA for a minimum of 30 minutes on five days each week, in bouts of at least ten minutes, or strenuous intensity aerobic PA for a minimum of 20 minutes on three days each week, or a combination of moderate and strenuous intensity aerobic PA.

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Part 3

Physical activity promotion based on the Self-Determination Theory among insufficiently active older adults

CHAPTER 3.1

The long-term effectiveness of need-supportive physical activity counseling compared with a standard referral in sedentary older adults

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Abstract

This study compared the long-term effectiveness of three physical activity counseling strategies among sedentary older adults: a one-contact referral (REFER), a one-contact individualized walking program (WALK) and a multiple-contact individually-tailored and need-supportive coaching based on the Self-Determination Theory (COACH). Participants (*n* = 442) completed measurements before (pre-test), immediately after (post-test) and one year after (follow-up-test) a ten-week intervention. Linear mixed models demonstrated significant time by condition interaction effects from pre- to post-test. More specifically, WALK and COACH yielded larger increases in daily steps and self-reported physical activity than REFER. Similarly, self-reported physical activity increased more from pre- to follow-up-test in WALK and COACH compared with REFER. Autonomous motivation mediated the effect of perceived need-support on physical activity, irrespective of counseling strategy. These results demonstrate the long-term effectiveness of both a one-contact individualized walking program and a more time-consuming need-supportive coaching, especially in comparison with a standard referral to local opportunities.

Keywords: exercise promotion, referral, walking program, Self-Determination Theory, older adults, longitudinal intervention

Introduction

The number of older adults in Western societies is increasing rapidly. This results in enormous health care costs given that particularly this population group suffers from impaired functioning and well-being (Crews & Zavotka, 2006; Naughton, Bennett, & Feely, 2006). Despite the important role of physical activity (PA) in healthy ageing, a large proportion of the Western population does not attain the health norm of 30 minutes of moderate intensity PA on five days a week or 20 minutes of strenuous intensity PA three times a week (Kruger, Carlson, & Buchner, 2007; Peel, McClure, & Bartlett, 2005; Philippaerts et al., 2006; Taylor et al., 2004). Consequently, PA promotion among older adults has emerged as a public health priority.

Lifestyle interventions have yielded PA increases among older adults (e.g., Conn, Minor, Burks, Rantz, & Pomeroy, 2003; King, 2001; Opdenacker, Boen, Coorevits, & Delecluse, 2008). However, PA changes in the long term have been found to be inconsistent (Goldstein et al., 1999; Taylor et al., 2004; Van Der Bij, Laurant, & Wensing, 2002). Moreover, even with limited contact, lifestyle interventions are time- and labor-intensive, which hampers large-scale implementation.

In order to facilitate PA promotion in the wider community, the effectiveness of less time-consuming counseling procedures has been studied (e.g., Dugdill, Graham, & McNair, 2005; Morgan, 2005; Williams, Hendry, France, Lewis, & Wilkinson, 2007). In this respect, referring sedentary adults to supervised PA sessions has been shown to produce a significant increase in the number of participants performing moderate intensity PA (Williams et al., 2007). However, referral from a primary care practitioner to local exercise programs usually succeeds in the short term but is limited in terms of long-term PA engagement (Gusi, Reyes, Gonzales-Guerrero, Herrera, & Garcia, 2008; Williams et al., 2007).

Walking programs of low to moderate intensity constitute another effective and feasible approach to introduce older adults to regular PA (Fisher & Li, 2004; Lamb, Bartlett, Ashley, & Bird, 2002; Lee, Arthur, & Avis, 2007; Parkatti, Perttunen, & Wacker, 2012; Pelssers et al., 2013; Sugden et al., 2008; Taylor et al., 2004). However, it is difficult to draw strong and unambiguous conclusions on the effectiveness of walking schemes because of the substantial variety in the way walking interventions are implemented (e.g., pedometer use, supervision intensity and program duration, whether or not group-based or theoretically-grounded). Furthermore, according to Ogilvie et al. (2007), no studies on walking programs have shown long-term effects.

As mentioned above, referral and walking interventions are less time-consuming counseling procedures but have failed to demonstrate consistent long-term effects on PA. Most of these procedures lack an underlying theoretical framework, even though previous research has underscored the importance of implementing theoretically-grounded behavioral strategies in order to promote PA (in older adults) (Hillsdon, Foster, Cavill, Crombie, & Naidoo, 2005; King, 2001). More specifically, numerous studies suggest that a client-centered counseling approach, in which (older) adults' needs of self-determination are recognized, is especially appropriate to increase their PA (e.g., Biddle & Mutrie, 2008; Dacey, 2005; Ogilvie et al., 2007; Stathi et al., 2003; Taylor et al., 2004). Such need-supportive counseling strategies are based on

the Self-Determination Theory (SDT), which is a prominent theoretical framework to facilitate behavioral change (Deci & Ryan, 1985). SDT-based interventions aim at enhancing autonomous types of motivation for any given behavior (e.g., PA). People are autonomously motivated when they engage in an activity because the activity will help them to attain valued goals, because of the personal importance and meaningfulness of the activity or for reasons of interest, enjoyment or challenge. Autonomously motivated behavior is self-initiated rather than controlled, driven by external demands or to avoid feelings of guilt or shame. Because of its voluntary character, autonomous motivation (AM) is assumed to yield long-term engagement in PA, which is essential for healthy ageing (e.g., Ryan & Deci, 2000; Edmunds, Ntoumanis, & Duda, 2006; Silva et al., 2011). Autonomously motivated behavior can be obtained by supporting the three basic psychological needs postulated by SDT, i.e the need for autonomy (i.e. experiencing personal control with respect to activity engagement), the need for competence (i.e. experiencing success in attaining desired outcomes) and the need for relatedness (i.e. experiencing meaningful relationships).

Need-supportive programs have been shown to be effective in increasing PA (e.g., Chatzisarantis & Hagger, 2009; Fortier, Sweet, O'Sullivan, & Williams, 2007; Van Hoecke et al., 2012). However, the majority of the studies on need-supportive PA interventions have focused on younger and adult populations whereas SDT has yet to be applied in PA interventions among older adults (Dacey, 2005; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Nevertheless, the framework of SDT seems particularly relevant and applicable to this population group given that ageing may involve feelings of reduced personal control and competence (Dacey, Baltzell, & Zaichkowsky, 2008; Jette et al., 1998).

Based on the abovementioned reasoning, we implemented a SDT-grounded PA intervention with a sufficiently long follow-up period among sedentary older adults. Given the importance of considering the cost-effectiveness of a PA counseling strategy, a more time-consuming need-supportive coaching was compared with various one-contact counseling procedures. More specifically, the main purpose of the present study was to compare the short-term effects (i.e. immediately after the intervention) as well as the long-term effects (i.e. one year after the intervention) of three PA counseling strategies among older adults. The first counseling procedure was a standard referral to existing PA programs (i.e. REFER). This procedure consisted of a 15-minute contact with a Health Fitness Specialist who delivered a self-help booklet with information on local PA opportunities. The second strategy was the provision of an individualized walking program (i.e. WALK). This counseling method consisted of a 15-minute contact with a Health Fitness Specialist who explained a structured walking program in addition to providing a self-help booklet. Because of the structured format, it was assumed that the walking program inherently supported participants' need for competence. Therefore, WALK was considered to be partially need-supportive. The third counseling method was the provision of an individually-tailored program that was assumed to be fully need-supportive (i.e. COACH). This procedure consisted of a multiple-contact PA coaching by a Health Fitness Specialist who explicitly fostered participants' needs for autonomy, competence and relatedness.

The secondary purpose of this study was to test whether AM would mediate the short- and long-term intervention effects on PA. As mentioned above, SDT assumes that AM is a crucial concept to explain

sustained behavioral change. Consequently, evidence for the mediating role of AM would provide further support for the validity and utility of this theory with respect to PA promotion among older adults.

Three hypotheses were formulated based on the abovementioned assumptions. In Hypothesis 1, we predicted that, considering their need-supportive character, WALK and COACH would yield larger short- and long-term PA increases than REFER. In Hypothesis 2, we expected larger PA increases in COACH compared with WALK because of the following two reasons. First, COACH aimed to explicitly facilitate the three basic psychological needs whereas WALK only focused on (inherently) fostering the need for competence by providing a structured program. Second, interventions with more intense contact have been found to be more effective than those with less intense contact (Conn, Valentine, & Cooper, 2002). In Hypothesis 3, we predicted that, irrespective of intervention, higher levels of perceived need-support would be associated with higher PA levels through higher levels of AM.

Method

Recruitment and participants

A flow chart of the study is presented in Figure 1. The study took place in three regions across Flanders, the Flemish-speaking part of Belgium. Sedentary adults aged 60 years or older were invited to a locally-organized information session through advertisements in newspapers, internet-based announcements and pamphlets spread via physicians and socio-cultural organizations. In the information session, a Health Fitness Specialist (MSc) (i.e. participants' coach during the PA program) elaborated on PA health benefits, PA recommendations and opportunities to integrate PA in their daily routines. Additionally, information on study participation was provided. Older adults willing to participate but already attaining the PA health norm as prescribed by Haskell et al. (2007) were excluded (n = 229). More specifically, volunteers performing more than 150 minutes of moderate to strenuous PA during a typical week were not allowed to participate in the study. Furthermore, volunteers had to obtain a written medical clearance from their physician to participate in PA with fluctuating intensities. If necessary, they were referred to a medical officer to have an additional cardiovascular and respiratory examination (n = 24).

Procedure

After obtaining medical permission, a total of 442 participants contacted their coach to make an appointment for pre-test measurements. Three coaches were involved in the study, i.e. one per region. Pre-tests were completed at two points in time, with a one-week interval during which the participants wore a pedometer while maintaining their normal PA pattern. At the first contact point, the study purpose and procedures were explained and participants gave their written consent. At the second contact point, participants completed self-reports and were randomly assigned to three intervention conditions, i.e. (a) a PA referral condition, (b) an individualized walking condition, and (c) an individually-tailored need-supportive PA coaching condition. During the ten-week program, participants were allowed to keep the pedometer that was used during the measurements. Post- and follow-up-tests took place immediately after

and one year after the ten-week program, respectively. After post-tests, no contact occurred between coach and client. Participants were not aware of follow-up-tests until three weeks before these measurements took place. The study was approved by the Ethical Committee of the KU Leuven.

Figure 1. Flow chart of the study

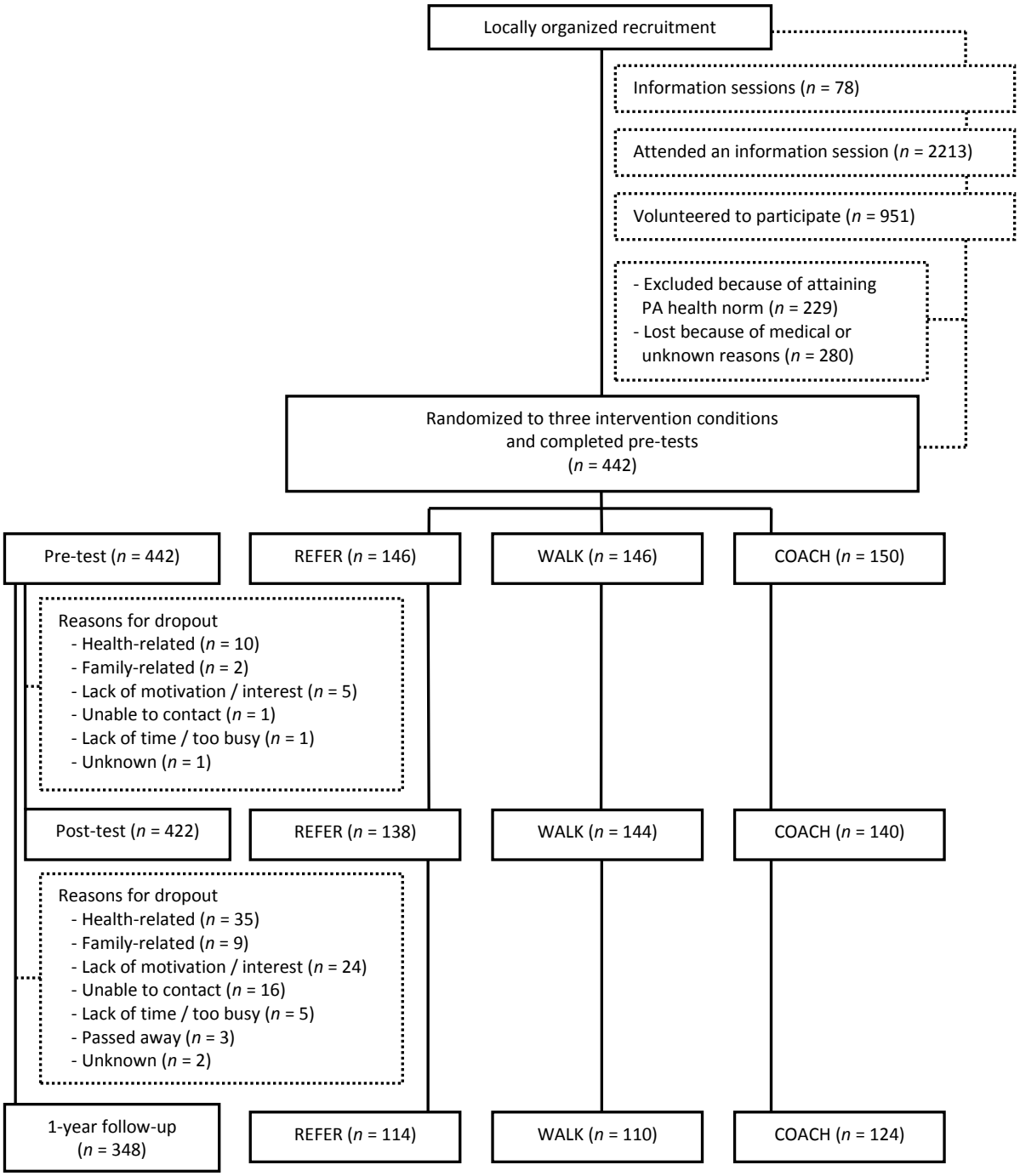

Figure 1. Response and participation rate throughout the recruitment procedure and intervention study. REFER, referral condition; WALK, walking condition; COACH, individually-tailored need-supportive coaching condition.

Intervention conditions

REFER

After pre-tests, participants of REFER attended a 15-minute informative session delivered by their coach. Given that the coach only explained and referred to locally-organized PA, his / her role was similar to the role of a sport promoter in Flemish communities. Participants received a self-help booklet with detailed practical information of local PA opportunities for older adults (e.g., location, costs). REFER can be considered as a minimal intervention condition because neither an individualized PA program nor individually-tailored need-supportive coaching was provided.

WALK

Consistent with REFER, WALK involved a 15-minute one-contact condition in which the coach referred the participants to locally-organized PA. In addition receiving a self-help booklet, participants of WALK were explained an individualized walking program. This easily accessible program consisted of structured weekly schedules of uninterrupted walks (described as number of steps) on most days of the week. Walking volume and intensity gradually increased and participants were encouraged to progress through the different levels of the walking program according to their individual abilities. Participants' initial level was determined by their score on the six-minute walk test, which was performed during pre-tests. This walk test is considered to be a valid measure of physical fitness (Enright et al., 2003). Participants could accomplish the program on their own or in a social context (e.g., with significant others, in a social organization). The structured format and gradually increasing difficulty of the program were assumed to (inherently) facilitate participants' need for competence. Therefore, WALK was considered to be a partially need-supportive counseling procedure.

COACH

In addition to the abovementioned one-contact procedures, participants of COACH received individually-tailored PA coaching based on SDT. During the ten-week intervention, regular contact between coach and client took place. In an initial 60-minute face-to-face contact, several individual PA goals were set up according to the client's preferences and abilities. Goals, which were specified by PA type, location, time frame, company and possible barriers and solutions were written down in a personal weekly schedule. Besides endurance activities such as walking, the coach provided home-based exercises to improve the participant's strength, flexibility and balance. Every ten days, participants were supported through face-to-face contacts or booster phone calls (maximum 30 minutes), which have both been shown to be effective to change individuals' behavior (Opdenacker & Boen, 2008). During contact, the coach explicitly fostered the psychological needs postulated by SDT, i.e. the need for autonomy (e.g., by providing PA options), the need for competence (e.g., by providing positive feedback) and the need for relatedness (e.g., by expressing empathy). Moreover, PA goals were evaluated and modified if necessary, barriers were identified and

participants were stimulated to persist in their PA by using behavior change techniques (Abraham & Michie, 2008) and applying motivational interviewing (Miller & Rollnick, 2002).

Measurements

PA and AM were measured before (pre-test), immediately after (post-test) and one year after (follow-up-test) the intervention. Perceived need-support of the coach was only assessed at post-test.

Pedometer steps

The number of daily steps was measured by Omron pedometers (Walking Style One) which have been applied previously among Western populations (Pelssers et al., 2013; Sugden et al., 2008) and for which accurate reliability and validity have been shown (Holbrook, Barreira, & Kang, 2009). Participants were asked to wear the pedometer during all waking hours, except for water-based activities, for five to seven consecutive days including a weekend. A total of five measurement days is assumed to provide sufficient information on daily steps given the recommended four days to reliably estimate usual PA (Hart, Swartz, Cashin, & Strath, 2011). The weighted mean of daily steps on weekdays and during the weekend (i.e. (3 x mean of steps on weekdays + 2 x mean of steps on weekend days) /5) was used for further analyses.

Self-reported PA

A self-reported measure of PA was obtained by a modified version of the Godin Leisure-Time Exercise Questionnaire (GLTEQ) for which test-retest reliability and adequate validity have been demonstrated (Gionet & Godin, 1989; Godin & Shephard, 1985; Kriska & Caspersen, 1997). This brief and easy comprehensible questionnaire has frequently been used in Western populations (e.g., De Bacquer et al., 2010; Edmunds et al., 2006; Pelssers et al., 2013). Participants reported the frequency of mild, moderate and strenuous PA bouts of at least 20 minutes that they performed in a usual seven-day period during the past month. The frequencies were weighted by their metabolic equivalents, i.e. three, five and nine respectively, and summed to obtain an overall measure of self-reported PA.

AM

AM was assessed by four items of the Dutch version of the Behavioural Regulation in Exercise Questionnaire-2 (Markland & Tobin, 2004), which has been shown to be valuable in Flemish populations (Verloigne et al., 2011). Items of the subscales of identified regulation (i.e. valuing the benefits of PA; two items) and intrinsic motivation (i.e. experiencing the pleasure of PA; two items) were used to obtain a score for AM (Fortier & Kowal, 2007). Participants responded to each item on a five-point Likert scale, ranging from '1 = not at all true for me' to '5 = very true for me'. Cronbach's α at pre-, post- and follow-up-test were .68, .74 and .82, respectively, indicating sufficient to good internal consistency.

Perceived need-support of the coach

A modified version of the Teacher As Social Context Questionnaire (Belmont, Skinner, Wellborn, & Connell, 1988) was used to measure perceived need-support of the coach. This questionnaire has been applied in previous research among Western populations (e.g., Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009; Vansteenkiste, Sierens, Soenens, Luyckx, & Lens, 2009) and assesses the three dimensions of coaches' behavior postulated by SDT, i.e. autonomy (eight items; e.g., 'My coach listens to my opinion and ideas'), competence (eight items; e.g., 'My coach shows me how to solve problems for myself') and relatedness (eight items; e.g., 'My coach really cares about me'). Participants indicated their agreement with the items on a five-point Likert scale, ranging from '1 = completely disagree' to '5 = completely agree'. As suggested by Vansteenkiste, Sierens, Soenens, Luyckx, and Lens (2009), a general measure of perceived need-support, based on the 24 items, was used for further analyses. Very good internal consistency was shown with a Cronbach's α of .84.

Statistical analyses

SPSS 16.0 was used for data analysis (SPSS Inc, Chicago, IL, USA). Differences between conditions were assessed with one-way ANOVA and chi-square tests (χ^2). Linear mixed models with an unstructured covariance structure were used to analyze between-condition differences in change over time. Differences in changes over time between separate conditions were determined by contrast estimates. Mixed model analysis is a likelihood-based approach modeling all observations with no attempt at imputation or adjustment for missing values. Lane (2008) indicated this method as reliable and statistically-grounded for handling missing values in a longitudinal design. Indirect effects of perceived need-support on PA through AM were tested by the bootstrapping procedure (Preacher & Hayes, 2008). Bias-corrected confidence intervals (95% CI) of the indirect effects were generated with 2000 resamples. Mediation analyses were conducted with pre-test values of PA included as covariate. When participants' PA level exceeded three standard deviations or more from the PA mean score at pre-, post- or follow-up-test, they were considered as an outlier and therefore excluded from all analyses (steps: n = 14; self-reported PA: n = 32). No significant differences occurred with respect to the number of outliers between REFER, WALK and COACH (steps: χ^2 = 0.122, p = .941; self-reported PA: χ^2 = 0.739, p = .691). Furthermore, changes in PA were not significantly different between the three regions (3 (time) by 3 (conditions) by 3 (regions) ANOVA: steps: F = .835, p = .572; self-reported PA: F = .605, p = .767). Consequently, region was not included as between-factor for data analysis. Significance level was set at $p < .05$.

Results

Demographic profile

The mean age was 69.48 ± 6.71 years, with a minority of the participants (22.2%) aged 75 years or older. One third of the sample consisted of men. Most participants (64.3%) were married or lived together

with their partner. The average number of educational years was 12.08 ± 2.76, with 32.6% of the participants having obtained a college or university degree. The mean body mass index was 27.09 ± 3.93 kg/m², indicating that the sample was on average overweight. A self-reported score on health status of 3.63 ± 0.65 on a five-point Likert scale showed that participants initially estimated their health as moderate to good. No significant baseline differences occurred between REFER, WALK and COACH with respect to the abovementioned variables, except for marital status. More specifically, a larger proportion of the participants of COACH was married compared with REFER (χ^2 = 10.399, p = .006).

Dropout

The number of dropouts (i.e. participants who neither completed questionnaires nor wore the pedometer) and the reasons are presented in Figure 1. Dropouts were 4.5% and 21.3% at post- and follow-up-test, respectively, with no significant differences between REFER, WALK and COACH (post-test: χ^2 = 5.265, p = .072; follow-up-test: χ^2 = 2.425, p = .297). The main reasons for dropping out were a lack of interest and health problems (e.g., respiratory problems, infection). No significant differences emerged between dropouts and non-dropouts with respect to the abovementioned demographic variables, except for age. More specifically, dropouts at follow-up were significantly older than non-dropouts (F = 6.994, p = .008). Moreover, a significantly lower number of daily steps at baseline was found in dropouts compared with non-dropouts (post-test: F = 4.854, p = .028; follow-up-test: F = 4.271, p = .039).

Intervention effects on PA

PA at pre-test did not significantly differ between the conditions (steps: F = 0.176, p = .838, d = 0.02; self-reported PA: F = 2.283, p = .103, d = 0.06). No significant 3 (time) by 3 (conditions) interaction effect was found for pedometer steps (p = .129). However, mixed model analyses indicated a significant difference in change over time between the conditions for self-reported PA (p = .009) (Table 1; Figure 2). Furthermore, a main (3) time effect was found for pedometer steps (p < .001) and self-reported PA (p < .001), indicating an overall change in PA across the conditions. More specifically, overall significant increases were found in all three interventions for pedometer steps (REFER: F = 6.110, p = .003, d = 0.74; WALK: F = 16.878, p < .001, d = 1.41; COACH: F = 14.572, p < .001, d = 1.02) and self-reported PA (REFER: F = 41.191, d = 1.69; WALK: F = 89.696, d = 2.47; COACH: F = 147.552, d = 3.18; all p < .001).

Figure 2. Intervention effects on PA

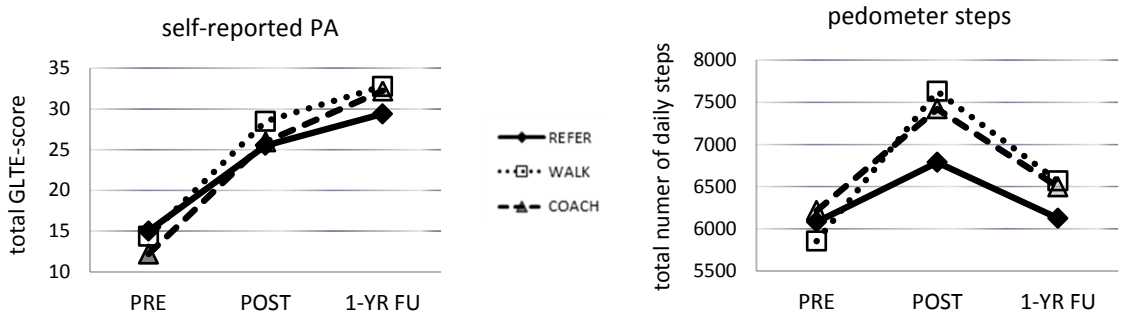

Figure 2. PA, physical activity; GLTE-score, physical activity score by the Godin Leisure-Time Exercise Questionnaire; PRE, physical activity score at pre-test; POST, physical activity score at post-test; 1-YR FU, physical activity score one year after the intervention; REFER, referral condition; WALK, walking condition; COACH, individually-tailored need-supportive coaching condition.

Table 1

Estimated means (SE) at pre-test, pre- to post-test and pre- to follow-up-test change scores for pedometer-based and self-reported PA in REFER, WALK and COACH, 3 (time) x 3 (conditions) interaction effects and (3) time effects for PA

	REFER	**WALK**	**COACH**	**3 x 3 interaction**		**Time**	
	Mean (SE)	**Mean (SE)**	**Mean (SE)**	***F***	**Cohen's *d***	***F***	**Cohen's *d***
Pedometer-based PA (steps/day)							
Pre	5877.542 (210.378)	5923.207 (213.364)	5734.334 (209.459)				
Δprepo	+ 618.849 (232.936)	+ 1384.384 (234.260)	+ 1224.784 (238.590)	1.797	0.27	36.215 ***	1.05
Δprefu	+ 39.766 (213.814)	+ 538.862 (215.439)	+ 460.606 (213.258)				
Self-reported PA (GLTE)							
Pre	14.883 (0.956)	14.195 (0.960)	12.099 (0.956)				
Δprepo	+ 9.614 (1.259)	+ 14.710 (1.247)	+ 13.968 (1.287)	3.406 **	0.18	239.278 ***	0.68
Δprefu	+ 13.617 (1.508)	+ 18.605 (1.549)	+ 20.020 (1.478)				

Note. SE, standard error; PA, physical activity; REFER, PA referral condition; WALK, walking condition; COACH, individually-tailored need-supportive coaching condition; Pre, pre-test value; Δprepo, change score from pre- to post-test; Δprefu, change score from pre- to follow-up-test; 3 x 3 interaction, interaction effect over (3) time and between (3) conditions; Time, overall time effect over the conditions; GLTE, score on Godin Leisure-Time Exercise Questionnaire.

**, $p < .01$; ***, $p < .001$

Contrast estimates (Table 2) showed significant (borderline) differences in pre- to post-test changes of PA between REFER on the one hand and WALK (steps: t = 2.463, p = .014; self-reported PA: t = 2.674, p = .008) and COACH on the other hand (steps: t = 1.933, p = .054; self-reported PA: t = 2.254, p = .025). Nevertheless, all three conditions significantly increased in pedometer steps and self-reported PA from pre- to post-test (steps: REFER: 95% CI = - 1017.649 to - 236.724, p = .002, d = 0.24; WALK: 95% CI = - 1853.616 to - 911.667, p < .001, d = 0.52; COACH: 95% CI = - 1673.129 to - 770.816, p < .001, d = 0.45; self-reported PA: REFER: 95% CI = - 12.026 to - 7.065, d = 0.74; WALK: 95% CI = - 17.672 to -11.754, d = 1.13; COACH: 95% CI = - 16.521 to - 11.369, d = 1.05; all p < .001). At post-test, one-way ANOVAs indicated (borderline) significant differences between the conditions with respect to pedometer-based and self-reported PA. More specifically, WALK and COACH showed significantly higher PA levels than REFER (steps: F = 3.089, p = .047, d = 0.31; WALK>REFER, p = .020; COACH>REFER, p = .061; self-reported PA: F = 2.937, p = .054, d = 0.29; WALK>REFER, p = .019).

Similarly to the pre- to post-test results, all three conditions significantly increased in self-reported PA from pre- to follow-up-test (REFER: 95% CI = - 17.173 to - 9.800, d = 0.92; WALK: 95% CI = - 21.728 to - 15.424, d = 1.24; COACH: 95% CI = - 22.434 to - 17.520, d = 1.37; all p < .001), with larger increases in WALK and COACH compared with REFER (respectively, t = 2.205, p = .028 and t = 2.893, p = .004) (Table 2). With respect to pedometer steps, the significant time by condition interaction effects disappeared from pre- to follow-up-test. However, significant pre- to follow-up-test increases in pedometer steps were found in WALK and COACH (WALK: 95% CI = - 1005.437 to - 94.189, p = .018, d = 0.21; COACH: 95% CI = - 861.556 to - 65.203, p = .023, d = 0.18) whereas no changes occurred in REFER (95% CI = - 439.530 to 374.741, p = .875, d = 0.02). No significant differences in PA were found between the three conditions at follow-up-test (steps: F = 1.636, p = .197, d = 0.26; self-reported PA: F = 2.138, p = .120, d = 0.27).

Participants who increased their PA level had significantly lower pre-test scores than those who did not increase in PA (pre- to post-test: steps: F = 57.527, d = 0.85; self-reported PA: F = 118.340, d = 1.56; pre- to follow-up-test: steps: F = 76. 099, d = 1.03; self-reported PA: F = 63.205, d = 1.38; all p < .001). This finding points out that especially individuals with initially lower PA levels benefited from the PA intervention.

Table 2

Condition difference changes from pre- to post-test and from pre- to follow-up-test for pedometer-based and self-reported PA

	Δprepo			Δprefu		
	Contrast estimate (SE)	**Cohen's *d***	**95% CI**	**Contrast estimate (SE)**	**Cohen's *d***	**95% CI**
Pedometer-based PA (steps/day)						
WALK vs. REFER	765.535 (310.766) *	0.25	154.474 to 1376.597	499.096 (300.952)	0.18	- 92.889 to 1091.081
COACH vs. REFER	605.935 (313.429) £	0.12	- 10.347 to 1222.217	420.411 (298.305)	0.15	- 166.387 to 1007.209
COACH vs. WALK	-159.600 (315.430)	0.05	- 779.809 to 460.608	- 78.685 (300.805)	0.03	- 670.387 to 513.017
Self-reported PA (GLTE)						
WALK vs. REFER	5.093 (1.905) **	0.27	1.348 to 8.838	4.989 (2.262) *	0.24	0.539 to 9.439
COACH vs. REFER	4.352 (1.931) *	0.23	0.557 to 8.147	6.404 (2.214) **	0.32	2.049 to 10.759
COACH vs. WALK	- 0.741 (1.923)	0.04	- 4.522 to 3.040	1.415 (2.242)	0.07	- 2.995 to 5.826

Note. SE, standard error; PA, physical activity; REFER, PA referral condition; WALK, walking condition; COACH, individually-tailored need-supportive coaching condition; Δprepo, change score from pre- to post-test; Δprefu, change score from pre- to follow-up-test; 95% CI, 95% confidence interval; GLTE, score on Godin Leisure-Time Exercise Questionnaire.

*, $p < .05$; **, $p < .01$; £, $p = .054$

Mediation analyses

Perceived need-support

Perceived need-support of the coach after the intervention was 4.500 ± 0.416, 4.553 ± 0.408 and 4.635 ± 0.306 in REFER, WALK and COACH, respectively. Despite the relatively high score in each condition, significant differences were found between the conditions ($F = 4.430$, $p = .012$, $d = 0.14$). More specifically, perceived need-support was significantly higher in COACH than in REFER ($p = .003$).

AM

Pre-, post- and follow-up-test scores of AM were 3.867 ± 0.791, 4.011 ± 0.757 and 3.994 ± 0.738, respectively. AM did not significantly differ between the three conditions (pre-test: $F = 0.318$, $p = .728$, $d = 0.02$; post-test: $F = 0.272$, $p = .762$, $d = 0.09$; follow-up-test: $F = 0.025$, $p = .975$, $d = 0.01$). Moreover, changes in AM were not significantly different between REFER, WALK and COACH (3 (time) by 3 (conditions)

interaction: $F = 0.608$, $p = .657$, $d = 0.13$; pre- to post-test: $F = 0.275$, $p = .760$, $d = 0.08$; pre- to follow-up-test: $F = 0.933$, $p = .395$, $d = 0.16$). AM significantly increased from pre- to post- and to follow-up-test (pre- to post-test: $F = 9.448$, $p = .002$, $d = 0.19$; pre- to follow-up-test: $F = 6.144$, $p = .014$, $d = 0.17$).

Table 3

Mediation effects of AM on pedometer-based and self-reported PA at post- and follow-up-test

	α-path	**β-path**	**αβ-path**			
	Coefficient (SE)	**Coefficient (SE)**	**Coefficient (SE)**	**95% CI of αβ**		
At post-test						
Pedometer-based PA (steps/day)						
AM	0.214 (0.105)*	376.669 (161.327)*	80.726 (57.792)	4.897	to	245.435
Self-reported PA (GLTE)						
AM	0.371 (0.098)***	2.145 (0.968)*	0.796 (0.447)	0.146	to	1.938
At follow-up-test						
Pedometer-based PA (steps/day)						
AM	0.344 (0.112)**	664.484 (155.639)***	228.367 (100.324)	77.653	to	493.557
Self-reported PA (GLTE)						
AM	0.317 (0.112)**	4.818 (1.187)***	1.529 (0.671)	0.442	to	3.193

Note. Pre-test PA was included as covariate; AM, autonomous motivation; PA, physical activity; α, estimate of perceived need-support at post-test on the proposed mediator, i.e. AM; β, estimate of the direct effect of the proposed mediator on PA while controlling for the effect of perceived need-support; αβ, estimate of the indirect effect of perceived need-support on PA through the proposed mediator; SE, standard error; 95% CI, 95% bias corrected confidence interval with the empirically derived bootstrapped sampling distribution of αβ (result of 2000 bootstrap resamples); GLTE, score on Godin Leisure-Time Exercise Questionnaire.

*, $p < .05$; **, $p < .01$, ***, $p < .001$

Mediation through AM

Bootstrapping analyses (Table 3) demonstrated significant effects of perceived need-support on AM at post- and follow-up-test (α-path). This means that, irrespective of intervention condition, the higher the perceived need-support after the intervention, the more participants were autonomously motivated to engage in PA, even one year after the intervention. Moreover, significant β-paths indicated that higher levels of AM were associated with higher PA levels, which is consistent with SDT-based assumptions. Confidence intervals demonstrated a significant contribution of AM to the indirect effect of perceived need-support on PA (αβ-path). At post-test, the mediator models with AM as a proposed mediator explained 29.6% ($R^2 = 0.2960$, $F = 49.842$, $p < .001$) of the variance in pedometer-based PA and 8.5% ($R^2 = 0.0849$, $F = 11.849$, $p < .001$) of the variance in self-reported PA. At follow-up-test, respectively 33.7% ($R^2 = 0.3370$, $F = 48.387$, $p < .001$) and 11.4% ($R^2 = 0.1135$, $F = 12.980$, $p < .001$) of the variance in PA could be explained by the mediator models.

Discussion

This study was designed to compare the (long-term) effects of three PA promotion strategies among older adults: (a) a one-contact referral to existing local PA opportunities (i.e. REFER), (b) a one-contact provision of an individualized walking program (i.e. WALK), and (c) a multiple-contact individually-tailored PA coaching based on SDT (i.e. COACH). As hypothesized and consistent with previous research on PA promotion, post-intervention PA increases were found in REFER, WALK and COACH (e.g., Chatzisarantis & Hagger, 2009; Gusi et al., 2008; De Greef, Deforche, Tudor-Locke, & De Bourdeaudhuij, 2010; Ogilvie et al., 2007). These findings suggest that various PA promoting strategies can be successful in enhancing PA in sedentary older individuals who are motivated to increase their PA level. Furthermore, previous research is extended by demonstrating effects one year after the intervention. This is noteworthy given that, according to Van Der Bij, Laurent, and Wensing (2002), the few intervention studies on older adults that did examine PA effects in the long term revealed inconsistent results.

Although a standard referral produced significant improvements in PA, WALK and COACH, which were (partially) need-supportive counseling procedures, yielded larger PA increases. This finding, although more pronounced from pre- to post-test than from pre- to follow-up-test, is consistent with hypothesis 1 and suggests that providing sedentary older adults an individualized program and approaching them in a need-supportive way is more effective than referring them to local PA. In accordance, Orrow et al. (2012) found no evidence to recommend referral schemes over counseling interventions. The larger improvements in WALK compared with REFER are consistent with Lamb, Bartlett, Ashley, and Bird (2002), who stated that health walks are more effective in increasing moderate intensity PA than merely providing information. In addition, several reasons could explain the larger PA increases in COACH compared with REFER. First, COACH demonstrated higher levels of perceived need-support than REFER, which is assumed to facilitate (long-term) behavioral change (Deci & Ryan, 2000). Second, a larger proportion of the participants in COACH was married compared with REFER. Accordingly, COACH reported higher levels of perceived social support from family than REFER, which might have enhanced the effectiveness of COACH. Third, COACH involved a multiple-contact procedure whereas REFER was limited to a single 15-minute contact between coach and client. This difference in attention may have produced higher PA levels in COACH compared with REFER. Furthermore, given that a structured and individualized PA plan was designed in WALK and COACH, the PA increases are consistent with the Goal-setting Theory of Locke and Latham (1990), which underscores the importance of concrete and realistic goal-setting to change indivduals' behavior.

Contrary to hypothesis 2, no significant differences in PA emerged between WALK and COACH. The similar PA pattern in these two conditions suggests that facilitating the need for competence by providing a structured program and explicitly fostering individuals' basic psychological needs during coaching can be equally effective in increasing PA among older adults. This is consistent with previous research on PA promotion, in which it was suggested that supporting only one psychological need postulated by SDT can be sufficient to produce positive effects in older adults (Dunn, Andersen, & Jakicic, 1998; Stewart et al., 2001). More specifically, feelings of competence might have been facilitated by the structure of the walking

program; By providing concrete and realistic weekly walking schemes with progressively increasing volume and intensity, participants were likely to experience success. Due to the format of the walking program, participants' needs for autonomy and relatedness might also be supported inherently, in addition to their need for competence. Specifically, feelings of control might have been facilitated by providing participation as well as program autonomy. Finally, interpersonal relatedness might have been facilitated by completing the walks with meaningful others, assuming that walking is considered as easily accessible and would therefore constitute the preferred type of PA among older adults (Ogilvie et al., 2007). With respect to the individually-tailored need-supportive program, the coach explicitly fostered participants' need for autonomy, the need for competence and the need for relatedness.

The need-supportive character of the interventions in both WALK and COACH appears to be confirmed by the absence of significant differences in perceived need-support between these two interventions. However, the provided need-support in WALK is implicit to the program and thus rather hypothetical. Moreover, there may also be other explanations for the PA increases in WALK (e.g., walking as the preferred PA type among older adults). Furthermore, it should be noted however that perceived need-support was rated high (i.e. over 4.50 on a five-point Likert scale) in all three conditions, and thus also in REFER. This is possibly inherent to the participants' sample, i.e. a motivated and probably grateful population that is pleased to contribute to a scientific PA program. Within this population, every positive contact (e.g., the 15-minute informative session) might have been experienced as need-supportive.

Besides the probably need-supportive perception of the 15-minute contact, several reasons can explain the improvements in REFER. First, given that participants were already motivated to increase their PA, an informative session might have been sufficient to lead them into PA behavior. Second, all participants received a pedometer after pre-tests, which could have resulted in measurement and motivational effects on the increase of PA (Kang, Marshall, Barreira, & Lee, 2009). Third, the pre- to post-test increases in PA may to some extent reflect a Hawthorne effect, meaning that individuals might have changed their PA behavior because of their participation in the study and to please the coaches. However, the increases in PA were substantial and lasted in the long term, suggesting a sustained intervention effect in REFER as well.

Although the pedometer-based and self-reported measures of PA showed similar patterns from pre- to post- and to follow-up-test (i.e. significant increases), a discrepancy emerged from post- to follow-up-test. Specifically, the total number of steps declined after the intervention whereas self-reported PA further increased, with no differences between the intervention conditions. Several reasons may account for these different post-intervention PA patterns: (a) Different instruments measure different types of PA: Pedometers mainly measure activities that include steps whereas the GLTEQ also asks for a wide range of activities that do not generate steps, e.g. upper body movements or swimming; (b) Different measurement tools refer to a different period of time: The number of daily steps specifically referred to the previous five to seven days whereas self-reported PA addressed a typical week during the past month; (c) Different measurement tools approach various PA intensities in a different way: Pedometers do not take into account

various PA intensities whereas the overall PA score specified by the GLTEQ is obtained by weighting the frequencies of mild, moderate and strenuous PA by three, five and nine, respectively. Given that especially moderate and strenuous PA increased from post- to follow-up-test, post-intervention increases in self-reported PA should have been less pronounced when intensity was not (or to a lesser extent) taken into account; (d) An overshooting effect or hyper reaction of PA may have occurred at post-test: Given that participants knew that they would be measured again after the intervention, they may have produced more efforts to live up to the perceived expectations. The hyper reaction of PA can also be attributed to seasonal effects given that post-tests occurred during summer.

The abovementioned discrepancy between pedometer steps and self-reported PA post-intervention emphasizes the multidimensional and complex character of PA behavior. According to Warren et al. (2010), assessing PA is difficult and no single method can capture all PA subcomponents and domains of interest. Absolute values of PA should thus be interpreted with caution. However, despite the measurement issues involved in pedometer-based and self-reported assessment tools, both methods have been found to be valid and reliable for measuring PA (e.g., Gionet & Godin, 1989; Holbrook et al., 2009; Kriska & Caspersen, 1997; Sugden et al., 2008; Warren et al., 2010). Furthermore, the observed trends from pre- to post- and to follow-up-test on pedometer steps were generally supported by self-reports, although somewhat more pronounced.

As postulated by SDT (Deci & Ryan, 1985), social environments that support individuals' basic psychological needs facilitate autonomously motivated behavior. The voluntary character of this type of self-determined motivation is crucial for continued engagement in health behavior (Fortier, Duda, Guerin, & Teixeira, 2012). As proposed in hypothesis 3 and consistent with previous SDT-based research (e.g., Fortier et al., 2007; Van Hoecke et al., 2012), AM mediated the effect of perceived need-support of the coach on PA. These findings imply that, irrespective of condition, higher levels of perceived need-support were associated with higher PA through higher levels of AM, even one year after the intervention. To enlarge the effectiveness, PA promotion should thus focus on facilitating individuals' AM. More specifically, individuals should be encouraged to engage in and maintain PA behavior (a) for obtaining personally important PA outcomes (i.e. identified regulation), or (b) for its own sake (i.e. intrinsic motivation).

In order to demonstrate the relevance of the findings in terms of health promotion, the results were translated into PA levels needed to obtain health benefits. Tudor-Locke et al. (2011), who reported step-based recommendations that correspond with the current public health PA guidelines, indicated that older adults should accumulate approximately 7000 steps each day to gain health benefits. In the current study, 29.2%, 48.1% and 35.7% of the participants obtained this threshold at pre-, post- and follow-up-test, respectively. These findings point out the potential of various PA interventions to increase the proportion of older adults being physically active enough, even one year after the intervention.

Despite the positive influences of all three counseling strategies on PA behavior in older adults, WALK and COACH were found to be more effective than REFER. However, even though both WALK and COACH were more successful than REFER in increasing PA in the long term, it should be noted that the

counseling procedure of WALK was less time-consuming than the procedure of COACH. More specifically, WALK involved a 15-minute informative session compared with the regular contacts between coach and client in COACH. This cost-effectiveness makes the walking intervention particularly beneficial to implement in a wider community. The large-scale implementation potential of WALK as a one-contact strategy is worth mentioning given that most effective interventions involve regular face-to-face contact (Dunn et al., 1998).

Before concluding, specific strengths and limitations of this study should be pointed out. First, this study on need-supportive coaching involved a longitudinal intervention with a year-round follow-up period. This design allowed us to identify long-term causal relationships between the intervention, perceived need-support, AM and PA, rather than merely studying cross-sectional associations. Second, given the SDT-assumption that need-supportive coaching yields sustained behavior through AM, mediation effects were studied. This enabled us to understand why an intervention is effective prior to implementation in the wider community. Third, given that both pedometer steps and self-reported PA involve measurement issues, the use of both types of PA outcomes provided a more complete and accurate PA assessment.

A first limitation constitutes the lack of a strict control condition. This prevented us from drawing strong conclusions on the impact of the interventions relative to measurement and attention effects. More specifically, participants could have increased their PA level because of their participation in the study (e.g., testing effects) or because of the (multiple) contact point(s) with the coach (e.g., attention effects) rather than because of the characteristics of the counseling procedures. Consequently, the (magnitude of the) intervention effects might have been slightly overestimated. However, the demonstrated effectiveness in the long term suggests substantial intervention effects. Moreover, given that ageing is associated with a decreased engagement in PA, the pre- to follow-up-test increases in PA suggest that all three intervention conditions have the potential to counteract the age-related decline in PA. Because participants were sedentary older adults motivated to increase their PA level, we considered it more ethical to include a minimal intervention rather than no-treatment condition. Second, recruitment occurred through media campaigns which entailed voluntary participation in the study. Consequently, the sample consisted of sedentary but relatively healthy and highly educated older adults who were initially already motivated to increase their PA. This self-selection recruitment procedure reduces the generalizability of the findings to older adults who are less motivated, have less education and are in poorer health.

In conclusion, this study provides evidence for the effectiveness of three PA programs varying in counseling method and intensity among sedentary older adults. Given their one-contact character, procedures such as referral or the provision of a structured walking program appear to be potentially effective health promoting strategies to implement at a large scale. However, an individualized and (partially) need-supportive PA program seems to be more successful in long-term PA engagement than referral to widespread PA opportunities. The findings underscore the importance of facilitating AM in the transition from an inactive to regularly active lifestyle in older adults. The intervention study constitutes a promising step in the promotion of PA among older adults in the wider community, especially in those with initially low PA levels.

Acknowledgements

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Endnote

The term 'sedentary' refers to 'not attaining the PA recommendations for health as prescribed by Haskell et al. (2007)', i.e. in addition to performing daily activities that last less than ten minutes or that are of mild intensity, accumulating at least moderate intensity aerobic PA for a minimum of 30 minutes on five days each week, in bouts of at least ten minutes, or strenuous intensity aerobic PA for a minimum of 20 minutes on three days each week, or a combination of moderate and strenuous intensity aerobic PA.

Participants were Flemish adults aged 60 years or more who did not attain the PA recommendations for health as prescribed by Haskell et al. (2007). They were recruited via advertisements in local newspapers, internet-based announcements and pamphlets spread via physicans and socio-cultural organizations. Recruitment occurred in three regions across Flanders. However, the demographic characteristics among the participants of the study were slightly different from the demographics among the overall Flemish older population (Table 4) (Federale Overheidsdienst Economie, 2008, 2012; Scheerder et al., 2011). More specifically, male individuals and individuals aged over 80 years (i.e. the oldest old) were underrepresented in the participants' sample compared with the Flemish older adult population. With respect to education, a similar level was found in the participants' sample of the present study and the overall Flemish population. However, in the overall population, a smaller proportion of older adults compared to younger adults have a high education (OECD, 2013). Consequently, individuals with a higher education appear to be overrepresented in the participants' sample compared with the Flemish older adult population. Similarly, the educational level of the participants of the present study was higher than the educational level of members of the socio-cultural organization OKRA who were aged 60 years or more. Even though the sample of OKRA was considered as representative for the Flemish older adult population with respect to demographic characteristics such as gender, individuals with a lower educational level were probably somewhat overrepresented in the sample of OKRA compared with the Flemish older adult population.

With respect to PA, similar levels of self-reported PA were found in the participants' sample (at baseline) and the sample of OKRA. However, it should be noted that results on PA in the present study included all types of PA that lasted for 20 minutes or more, i.e. PA related to sport as well as PA related to household chores or gardening. By contrast, the results on PA that were based on the sample of OKRA only included sport-related PA. Consequently, when taking into account all types of PA, participants of the OKRA-sample would probably be more physically active than those of the present study. Table 4 provides an overview of several demographics and the PA level of the participants' sample compared with those of the Flemish older adult population.

Table 4

Demographic characteristics and PA level of the participants' sample at baseline compared with those of the Flemish population aged 60 years or more.

Characteristic	Participants' sample (n = 442)	Reference group [a]	
Age-related characteristics			
Proportion of individuals aged ≥ 60 years (%)	100		23.6 [2]
Proportion of individuals aged between 60 and 70 years (%)	60.9		44.0 [1]
Proportion of individuals aged between 70 and 80 years (%)	31.4		36.1 [1]
Proportion of individuals aged over 80 years (%)	7.7		19.9 [1]
Male (%)	33.3		44.8 [1]
Educational level (%) [b]			
Primary	31.0	31.4 [2]	74.7 [3]
Secondary	36.4	37.3 [2]	16.3 [3]
High	32.6	31.3 [2]	8.9 [3]
PA level			
Overall score on Godin Leisure-Time Exercise Questionnaire	13.7		10.3 [3,d]
Proportion of individuals attaining the PA recommendation for health (%) [c]	12.7		10.9 [3,d]

Note. Data are obtained from Federale Overheidsdienst Economie (2008, 2012) and Scheerder et al. (2011). PA, physical activity.

[a] Reference group: [1] Flemish population aged ≥ 60 years (n = 1455338); [2] Entire Flemish population (n = 7241955); [3] Members aged ≥ 60 years of the socio-cultural organization OKRA, considered as representative for the Flemish population of this age category with respect to demographic characteristics such as gender (n = 949).

[b] A primary educational level refers to a minimum of nine years of education; A secondary educational level refers to a minimum of twelve years of education; A high educational level refers to 15 or more years of education.

[c] An overall score of 27 on the Godin Leisure-Time Exercise Questionnaire corresponds with the physical activity recommendation for health as prescribed by Haskell et al. (2007) (Scheerder et al., 2011).

[d] The score on the Godin Leisure-Time Exercise Questionnaire only included PA related to sport. By contrast, PA related to household chores or gardening was not included in the overall PA score.

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CHAPTER 3.2

Effects of need-supportive physical activity counseling on well-being: A two-year follow-up among sedentary older adults

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Abstract

This study evaluated the long-term effectiveness of multiple physical activity counseling strategies on subjective health among older adults. Sedentary older adults (n = 442) were randomized to three programs: (1) a one-contact referral to locally-organized physical activities, (2) a one-contact provision of a walking program, and (3) a ten-week multiple-contact physical activity coaching based on the Self-Determination Theory. Self-reports on well-being, trait anxiety and physical activity were completed at baseline (pre-test), and ten weeks after (ten-week follow-up), one year after (one-year follow-up) and two years after (two-year follow-up) pre-tests. All three programs yielded improvements in well-being and trait anxiety from pre-test to ten-week follow-up and to one-year follow-up. From pre-test to two-year follow-up, no changes emerged in well-being whereas trait anxiety significantly increased. Changes over time in well-being and anxiety were not significantly different between the PA programs. Changes in physical activity significantly contributed to the prediction of changes in well-being and trait anxiety. The findings demonstrate the year-round effectiveness of physical activity counseling on subjective health among older adults, irrespective of counseling strategy. However, a relapse to baseline level occurred two years after the intervention. Physical activity appears to be an important determinant of older adults' well-being.

Keywords: ageing, mental health, exercise, evidence-based research, community-based research

Introduction

The increasing life expectancy in Western societies yields a continuously growing proportion of older adults.[1] Given that advanced age is associated with a higher risk of chronic diseases, the ageing population results in a substantial health and economic burden.[2, 3] Regular physical activity (PA) has been recognized as a key strategy to prevent older adults from diseases and to improve their health, quality of life and well-being.[4-5] In particular, PA has been shown to produce increases in physical fitness and functional performance. Moreover, quantitative and qualitative research has demonstrated beneficial effects of PA on various indicators of subjective well-being and mental health such as vitality, mood, anxiety, cognitive functions and self-esteem.[4, 6-10]

Despite the numerous positive outcomes of PA interventions on health and well-being, several studies have failed to find a positive association between PA and subjective well-being.[11-16] For example, results of the Better Ageing Project[15] in which healthy older adults were randomized to a PA condition and a control condition showed only minor psychological benefits of a six-month structured PA program including aerobic exercises, strength training, tai chi and flexibility exercises. Moreover, longitudinal research of Perrig-Chiello and colleagues[16] found that an eight-week resistance training program is not effective in improving subjective health, well-being or memory among normally active adults aged between 65 and 95 years. Furthermore, based on a randomized controlled trial among older adults living in long-term care facilities but without progressive or terminal illness, Chin A Paw et al.[14] concluded that neither strength training nor all-round functional training of moderate intensity yields improvements in quality of life, vitality or depression in this population group.

The following three reasons might explain the inconsistent findings on the association between PA and well-being. First, longitudinal research on the effects of PA on subjective health varies largely with respect to the intervention procedures (e.g., counseling method, program duration, PA type and intensity). The majority of the studies have focused on the effects of aerobic forms of PA on well-being. However, well-being has not only been shown to be improved by aerobic training but also by other types of PA such as strength training, functional training or flexibility.[17-19] For example, McAuley et al.[18] demonstrated that both a six-month aerobic (walking) program and a six-month PA program based on stretching and toning are effective in improving happiness, life satisfaction and loneliness among healthy sedentary adults. Even though endurance training including walking appears to be most effective[7-8, 10, 14, 20-23], it remains unclear which type of PA intervention is most valuable to enhance well-being among older adults.

Second, well-being is a subjective and wide-ranging construct for which a diversity of operational definitions exist.[9, 12, 24] According to Diener et al.,[25] the applied definition of well-being is often not made explicit but is rather implied by the specific measurement that is used. Moreover, the concept of subjective health and well-being comprises both positive (e.g., vitality, life satisfaction and happiness) and negative components (e.g., anxiety, depression and loneliness), which can be influenced differently.[26] In this respect, Van Hoecke et al.[27] found improvements in physical well-being but not in psychological well-being after a four-month PA program among sedentary employees. Furthermore, Opdenacker and colleagues[28] showed a

significant decrease in anxiety but found no changes in well-being after a six-month PA intervention in rural older women. The contrasting results of a PA program on different indicators of subjective health highlight the importance of approaching well-being as a multidimensional construct.

Third, previous research has underscored the importance of a theoretical foundation in health promoting strategies.[29] However, many of the PA interventions studying the effects on subjective health and well-being lack an underlying theory.[12] Given that ageing may involve reduced feelings of personal control and competence, the Self-Determination Theory[30] (SDT) has been postulated as an appropriate framework for health behavior changes and optimal psychological functioning among older adults.[31-34] SDT assumes that an individual's motivation for behavioral actions can vary from controlling (i.e. behavior regulated by external demands) to autonomous (i.e. behavior regulated by one's personal values). Due to its volitional character, autonomous motivation is assumed to produce long-term behavior. This form of motivation can be facilitated by a social environment providing support for the three basic psychological needs, i.e. the need for autonomy, the need for competence and the need for relatedness. Autonomy refers to the performance of a behavior with a sense of choice and personal control; Competence implies the pursuit of mastering a behavior within a challenging environment; Relatedness reflects the experience of belongingness with meaningful others.

SDT-based counseling has repeatedly been shown to be effective in facilitating health promoting behavior such as PA.[35] In addition to the beneficial effect of need-supportive counseling on behavioral change, the satisfaction of the three basic psychological needs across the life span is assumed to be essential to experience an ongoing sense of integrity and well-being.[31, 36-38] More specifically, the pursuit and attainment of one's personal goals is expected to produce feelings of need-satisfaction and consequently to enhance individuals' subjective health and well-being.

Although SDT appears to be a promising approach to increase individuals' (long-term) PA level and to improve their well-being, literature on need-supportive counseling involves several limitations. First, previous research on need-supportive PA coaching has rarely studied the direct and indirect effects on well-being, especially among older adults.[18, 22, 35, 38-40] Given that well-being is considered to be a crucial factor of successful ageing[9, 12], research on the effects of SDT-based PA programs on subjective health in older adults may be valuable. Second, even though well-being is associated with PA on the one hand and with need-satisfaction on the other hand, the extent to which (one of) those constructs contribute to the prediction of well-being is less clear.[12, 13, 24, 38, 41-42] An understanding of the primary factors that result in improved levels of well-being may advance the development and implementation of effective public health promoting strategies. Third, PA studies among clinical populations have mainly examined the effects on negative components of subjective health (e.g., anxiety). By contrast, PA interventions among non-clinical samples have mostly focused on positive health outcomes (e.g., mood).[11] Given that PA engagement has been demonstrated to be an effective treatment for anxiety and depression[6, 19, 43-44], and that advanced age is associated with an increased risk of depression[45, 46], it may be valuable to evaluate the potential of PA engagement in the prevention of psychological health problems among non-clinical healthy (older) adults.[12]

Fourth, most research on the association between PA and subjective health has been cross-sectional.[24] Moreover, only a limited number of the studies that involve a longitudinal design have focused on the long-term effects of PA on well-being, i.e. one year or more after the PA program.[4, 7, 15, 18] Knowledge on the duration of the effects may be helpful to determine which aspects are needed in a PA intervention to improve indicators of subjective health in the long term. Fifth and finally, to our knowledge, no studies have compared the effectiveness on well-being of one-contact PA counseling and more time-consuming PA coaching. In order to implement the most optimal strategy, comparing the (cost-) effectiveness of different health promoting procedures may be valuable.

Based on the abovementioned reasoning, the main purpose of this study was to examine whether different PA promoting strategies varying in counseling method and intensity among healthy sedentary older adults yield improvements in different indicators of subjective health in the short term (i.e. ten weeks after the beginning of the intervention) as well as in the long term (i.e. one year and two years after the beginning of the intervention). More specifically, we evaluated the effects of PA counseling on well-being (i.e. a positive indicator of subjective health; closely related to physical fitness and PA because of its physical component) and on trait anxiety (i.e. a negative indicator of subjective health; characterizing individuals' personality). The following three PA interventions were compared: (1) a one-contact PA referral in which a Health Fitness Specialist explained existing locally-organized PA opportunities (i.e. REFER); (2) a one-contact advice session in which a Health Fitness Specialist provided a structured walking program in addition to the referral (i.e. WALK). Due to the structured format and the gradually increasing difficulty of the walking program, WALK was assumed to implicitly support participants' need for competence; and (3) a ten-week multiple-contact individually-tailored PA coaching in which a Health Fitness Specialist explicitly fostered participants' need for autonomy, need for competence and need for relatedness (i.e. COACH). The secondary purpose of the study was to examine the extent to which older adults' changes in PA on the one hand and their perceived need-support of the coach on the other hand contribute to their changes in well-being and trait anxiety.

The year-round effects of the three intervention conditions on total number of daily steps and on self-reported PA are described in detail in Van Hoecke and colleagues.[47] Compared with baseline, REFER, WALK and COACH have been shown to yield increases in PA ten weeks after the beginning of the intervention as well as one year after the beginning of the intervention. However, larger PA increases have been found in WALK and COACH than in REFER. The associations between perceived need-support and PA were mediated by autonomous motivation, irrespective of counseling strategy. Because of the demonstrated PA increases in the three conditions[47] and the positive association between PA and health in the literature, we hypothesized that all PA programs would yield improved levels of subjective well-being and trait anxiety immediately after, one year after and two years after the intervention. Furthermore, because previous research has indicated that fulfilling the basic psychological needs enhances vitality and well-being[31, 38], we expected that the improvements in well-being and anxiety would be larger in WALK and COACH compared with REFER. Moreover, because need-support was provided more explicitly in COACH

than in WALK, it was hypothesized that COACH would produce larger increases in subjective health than WALK. Finally, given the abovementioned positive influence of PA and perceived need-support on health, both constructs were expected to significantly contribute to the variance in well-being and anxiety in all three interventions.

Methods

Recruitment

The flow chart of the participants' recruitment is presented in Figure 1. Flemish adults aged 60 years or older were invited to an information session on PA health benefits and recommendations provided by a Health Fitness Specialist (MSc) (i.e. participants' PA coach during the intervention). Additionally, information on study participation was provided. Recruitment took place in different regions across Flanders and occurred via local newspapers, internet-based announcements, physicians and socio-cultural organizations. Older adults who volunteered to participate in the PA program but already attained the PA health norm,[48] were excluded from the study (n = 229).

Procedure

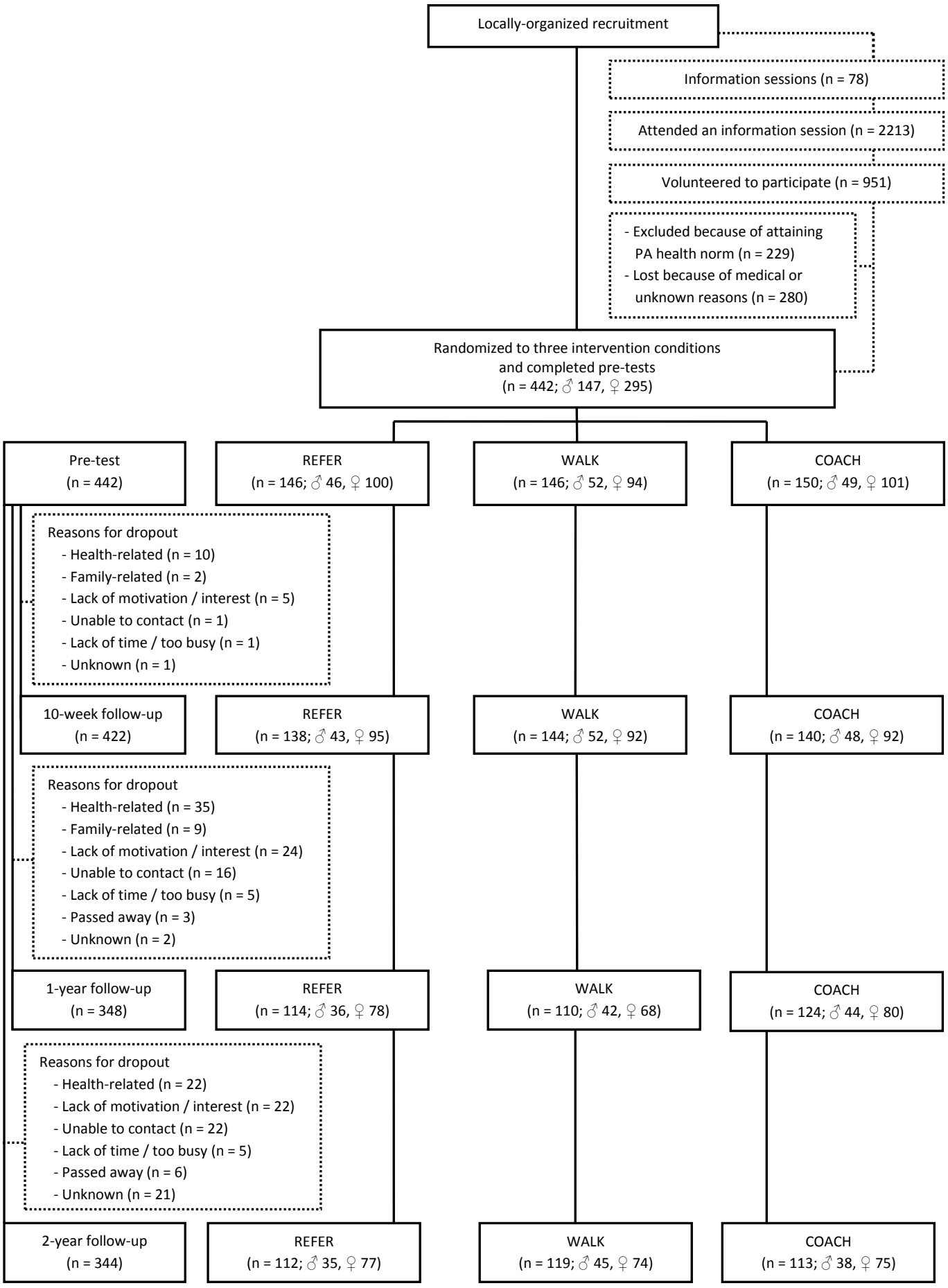
The study purpose and procedures were explained and participants (n = 442) gave their written consent. After pre-tests, participants were randomly assigned to three PA programs, i.e. (1) a one-contact PA referral, (2) a one-contact walking program, and (3) a ten-week multiple-contact individually-tailored need-supportive PA program. In order to avoid contamination between the conditions, partners and close friends who were engaged in the same socio-cultural organization were assigned to the same intervention condition. Measurements were completed before the intervention (i.e. pre-test) as well as ten weeks after (i.e. ten-week follow-up; 10-WK FU), one year after (i.e. one-year follow-up-test; 1-YR FU) and two years after the beginning of the intervention (i.e. two-year follow-up-test; 2-YR FU). Before their study participation, participants were informed on the occurrence of 10-WK FU measurements but not on the occurrence of 1-YR FU and 2-YR FU measurements. Approximately four weeks before 1-YR FU and 2-YR FU, participants were sent a letter in which they were informed on the re-occurrence of measurements. In order to avoid dropout, non-responders were sent a reminder and were contacted by phone by a bachelor in Kinesiology. The study was approved by the Ethical Committee of the KU Leuven.

Intervention conditions

PA referral condition

REFER consisted of a single 15-minute face-to-face advice session in which the coach explained and referred the older adults to locally-organized PA such as yoga, dancing, swimming, tennis and cycling. Participants received a booklet with practical information (e.g., location, hour, contact details) on the PA opportunities in their community. In addition, the booklet included information on the sport infrastructure

Figure 1. Flow chart of the study.



REFER, physical activity referral condition; WALK, walking condition; COACH, individually-tailored need-supportive physical activity condition.

in the community, on the recommended PA level of 30 minutes of moderate intensity PA a day[48] and on how individuals can integrate more PA into their daily routines (e.g., by climbing stairs instead of using the elevator). Given that the coach's role was only to explain and refer, his / her role was similar to the role of a sport promoter in Flemish communities. Neither a structured PA program nor individually-tailored coaching was provided. Therefore, REFER can be considered as a minimal intervention condition.

Walking condition

In addition to the referral and the provision of the self-help booklet, participants of WALK were explained a structured walking program during the single 15-minute face-to-face contact with their coach. The walking program comprised weekly schedules of uninterrupted walks with progressively increasing volume and intensity on most days of the week. Participants were encouraged to progress through the different levels of the walking program according to their individual abilities. The structured format and the gradually increasing difficulty of the program were assumed to foster individuals' need for competence. Therefore, WALK was considered to be partially need-supportive.

Individually-tailored need-supportive PA condition

In addition to the referral and the provision of both the self-help booklet and the walking program, participants of COACH received a ten-week individually-tailored PA coaching based on SDT. In an initial face-to-face session with their coach, participants wrote down several PA goals in a personal weekly schedule. The goals were specified by PA type, location, time frame and company. Moreover, they were consistent with their preferences and abilities. Every ten days, participants were supported by their coach through face-to-face contacts or booster phone calls, according to their preferences and needs. More specifically, the coach explicitly fostered the basic psychological needs outlined by SDT, i.e. the need for autonomy (e.g., by exploring PA options), the need for competence (e.g., by providing positive feedback) and the need for relatedness (e.g., by expressing empathy). In addition, barriers were identified, goals were modified if necessary and participants were stimulated to persist in their PA program by using behavior change techniques (e.g., suggesting prompts and cues) and applying motivational interviewing.[49-50]

Measures

Control variables

During pre-tests, participants were asked for their age, gender and marital status. Moreover, self-rated health status (one item) was measured at baseline on a five-point Likert scale ranging from '1 = I feel very unhealthy' to '5 = I feel very healthy'.

Criterion variables

Subjective well-being was assessed with the Leuven Well-Being Scale.[51] This scale comprises items that refer to physical well-being (four items; e.g., 'I am satisfied with my body') and items that refer to psychological well-being (four items; e.g., 'I am happy with the person I am'). Participants indicated how frequently they agreed with the given statement on a seven-point Likert scale ranging from '1 = never' to '7 = always'. Cronbach's α coefficients at pre-test, 10-WK FU, 1-YR FU and 2-YR FU exceeded .86, indicating good internal consistency.

Trait anxiety was measured by 11 items of the Dutch version of the State-Trait Anxiety Inventory.[52] Trait anxiety is described as a relatively stable individual difference in anxiety proneness and refers to a general tendency to respond with anxiety to perceived environmental threats. Participants indicated how frequently they perceived the stated emotions (e.g., 'I am happy' or 'I feel safe') on a four-point Likert scale ranging from '1 = almost never' to '4 = almost always'. Cronbach's α coefficients exceeded .82 at pre- and follow-up-test measurements, indicating good internal consistency.

Predictor variables

PA was measured by a modified version of the Godin Leisure-Time Exercise Questionnaire[53] (GLTEQ), for which test-retest reliability and adequate validity have been shown.[54-55] This brief and easy comprehensible questionnaire asks participants to report their frequency of 20-minute bouts of mild, moderate and strenuous PA in a typical week during the previous month. An overall measure of self-reported PA was obtained by summing the frequencies weighted by their metabolic equivalents, i.e. three, five and nine, respectively.

Ten weeks after the beginning of the intervention, perceived need-support of the coach was assessed using a modified version of the Teacher As Social Context Questionnaire.[56] This questionnaire refers to the three dimensions of coaches' behavior postulated by SDT, i.e. autonomy (eight items; e.g., 'My coach listens to my opinion and ideas'), competence (eight items; e.g., 'My coach shows me how to solve problems for myself') and relatedness (eight items; e.g., 'My coach really cares about me'). Participants indicated their agreement with the items on a five-point Likert scale ranging from '1 = completely disagree' to '5 = completely agree'. As suggested by Vansteenkiste et al.[57], a general measure of perceived need-support, based on the 24 items, was used for analyses. Good internal consistency was shown with a Cronbach's α coefficient of .84.

Statistical analyses

Data analysis was conducted with SPSS 16.0 (SPSS Inc, Chicago, IL, USA). One-way ANOVAs and chi-square tests (χ^2) were used to assess differences between conditions. Changes over time between conditions in general and between separate conditions were determined by linear mixed models with an unstructured covariance structure and by contrast estimates, respectively. Given that mixed model analysis denotes each observation without adjusting for missing values, Lane[58] indicated this approach as reliable

and statistically-grounded for handling missing values in a longitudinal design. Hierarchical pairwise regression analyses were conducted to predict changes in well-being and trait anxiety by changes in PA and by perceived need-support. Participants who exceeded three standard deviations from the PA mean score at pre- or follow-up-test measurements were excluded from the regression analyses (n = 32). Significance level was set at $P < .05$.

Results

Participants

The final sample consisted of 66.7% female older adults. The majority of the participants (64.3%) was married or lived together with their partner. The mean age was 69.48 ± 6.71 years, with a maximum of 93 years; Respectively 60.9%, 31.4% and 7.7% of the participants were aged between 60 and 70 years, between 71 and 80 years, and over 80 years. The average number of years of education was 12.09 ± 2.76 years; Respectively 31.0%, 36.4% and 32.6% of the participants had a primary educational level (i.e. at least nine years of education), a secondary educational level (i.e. at least 12 years of education) and a high educational level (i.e. 15 or more years of education). Gender, age and years of education were not significantly different between the three conditions. A significantly larger proportion of the participants of COACH (i.e. 73.3%) was married compared with REFER (i.e. 56.8%) ($\chi^2 = 10.399$, $P = .006$).

Dropout

Dropout rates are shown in Figure 1. Respectively 4.5%, 21.7% and 22.2% of the participants dropped out at 10-WK FU, 1-YR FU and 2-YR FU. Health problems (e.g., low back pain, cancer) and a lack of interest were the most frequently reported reasons. The dropout rates were not significantly different between REFER, WALK and COACH (10-WK FU: $\chi^2 = 5.265$, $P = .072$; 1-YR FU: $\chi^2 = 2.425$, $P = .297$; 2-YR FU: $\chi^2 = 1.791$, $P = .408$). No significant differences emerged between dropouts and non-dropouts with respect to gender and baseline levels of well-being, trait anxiety and PA. However, self-rated health at baseline was significantly lower in dropouts compared with non-dropouts at 10-WK FU ($F = 16.881$, $P < .001$), at 1-YR FU ($F = 5.761$, $P = .017$) and at 2-YR FU ($F = 15.338$, $P < .001$). Moreover, dropouts were significantly older than non-dropouts at 1-YR FU ($F = 6.994$, $P = .008$) and at 2-YR FU ($F = 10.709$, $P = .001$). At 2-YR FU, a smaller proportion of dropouts was married or lived together with a partner compared with non-dropouts ($\chi^2 = 5.188$, $P = .023$).

Intervention effects

Multivariate analyses indicated that overall changes in well-being and trait anxiety were (borderline) significantly different between REFER, WALK and COACH (Roy's largest root: $F = 2.054$, $P = .129$). More specifically, changes in well-being and trait anxiety between the intervention conditions were (borderline) significantly different from pre- to 10-WK FU-test (Roy's largest root: $F = 2.188$, $P = .114$), from

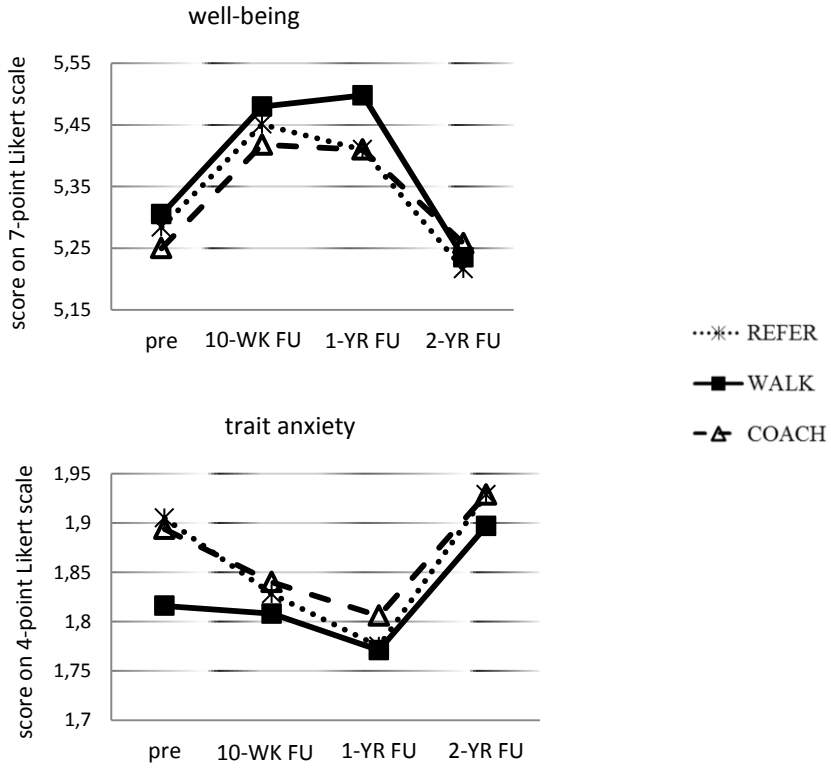
pre- to 1-YR FU-test (Roy's largest root: F = 3.172, P = .043) and from pre- to 2-YR FU-test (Roy's largest root: F = 2.825, P = .061).

Well-being

Well-being was not significantly different between REFER, WALK and COACH at pre-test (F = 0.143, P = .866), 10-WK FU (F = 0.119, P = .887), 1-YR FU (F = 0.662, p = .516) and 2-YR FU (F = 0.134, P = .874). An overall change over time emerged (P < .001) but no differences in overall changes were found between the conditions (P = .895) (Table 1). With respect to changes in well-being between REFER, WALK and COACH separately, no significant differences were found from pre-test to 10-WK FU, from pre-test to 1-YR FU and from pre-test to 2-YR FU.

Well-being significantly improved from pre-test to 10-WK FU and from pre-test to 1-YR FU (all P < .001) (Figure 2). More specifically, significant increases were found in all three conditions. Well-being did not change significantly from 10-WK FU to 1-YR FU (P = .769) but there was a significant decrease from 10-WK FU to 2-YR FU (P < .001) and from 1-YR FU to 2-YR FU (P < .001). The abovementioned changes resulted in the absence of a significant change in well-being from pre-test to 2-YR FU (P = .241), indicating a relapse to baseline level two years after the intervention.

Figure 2. Changes over time in well-being and trait anxiety.



REFER, physical activity referral condition; WALK, walking condition; COACH, individually-tailored need-supportive physical activity condition; pre, score at pre-test; 10-WK FU, score at ten-week follow-up-test; 1-YR FU, score at one-year follow-up-test; 2-YR FU, score at two-year follow-up-test.

Table 1. Estimated means (SE) at pre-test, pre- to ten-week follow-up-test, pre- to one-year follow-up-test and pre- to two-year follow-up-test change scores for well-being and trait anxiety in REFER, WALK and COACH, 4 (time) x 3 (conditions) interaction effects and (4) time effects for well-being and trait anxiety.

	REFER	WALK	COACH	4 x 3 interaction	Time
	Mean (SE)	Mean (SE)	Mean (SE)	*F*	*F*
Well-being					
Pre	5.284	5.305	5.250		
	(.074)	(.074)	(.073)		
Δprefu1	+ 0.167	+ 0.175	+ 0.168		
	(.071)	(.070)	(.070)		
Δprefu2	+ 0.126	+ 0.193	+ 0.160	0.375	21.310 ***
	(.077)	(.078)	(.075)		
Δprefu3	- 0.068	- 0.070	+ 0.008		
	(.077)	(.076)	(.076)		
Trait anxiety					
Pre	1.905	1.816	1.894		
	(.043)	(.041)	(.042)		
Δprefu1	- 0.077	- 0.008	- 0.054		
	(.041)	(.041)	(.039)		
Δprefu2	- 0.130	- 0.045	- 0.088	6.687	15.236 ***
	(.041)	(.047)	(.044)		
Δprefu3	+ 0.024	+ 0.081	+ 0.035		
	(.048)	(.046)	(.046)		

Note. SE, standard error; REFER, physical activity referral condition; WALK, walking condition; COACH, individually-tailored need-supportive condition; Pre, pre-test value; Δprefu1, change score from pre- to ten-week follow-up-test; Δprefu2, change score from pre- to one-year follow-up-test; Δprefu3, change score from pre- to two-year follow-up-test; 4 x 3 interaction, interaction effect over time (4) and between conditions (3); Time, time effect over time (4); *, $P < .05$; **, $P < .01$; ***, $P < .001$.

Trait anxiety

Trait anxiety was not significantly different between the conditions at pre-test ($F = 1.332$, $P = .265$), 10-WK FU ($F = 0.106$, $P = .900$), 1-YR FU ($F = 0.595$, $P = .552$) and 2-YR FU ($F = 0.580$, $P = .561$). An overall change over time emerged ($P < .001$) but no differences in overall changes were found between REFER, WALK and COACH ($P = .660$) (Table 1). With respect to changes in trait anxiety between REFER, WALK and COACH separately, no significant differences were found from pre-test to 10-WK FU, from pre-test to 1-YR FU and from pre-test to 2-YR FU.

Trait anxiety significantly improved from pre-test to 10-WK FU ($P = .004$), from 10-WK FU to 1-YR FU ($P = .020$) and consequently from pre-test to 1-YR FU ($P < .001$) (Figure 2). There was a significant increase in trait anxiety from 1-YR FU to 2-YR FU ($P < .001$) as well as from 10-WK FU to 2-YR FU ($P < .001$).

The abovementioned changes resulted in a significant increase in trait anxiety from pre-test to 2-YR FU (P = .021).

One-way ANOVAs revealed that participants who improved in well-being and trait anxiety showed respectively lower and higher baseline levels compared with participants who did not improve (pre-test to 10-WK FU: well-being: F = 44.917; trait anxiety: F = 24.124; pre-test to 1-YR FU: well-being: F = 40.458; trait anxiety: F = 13.451; pre-test to 2-YR FU: well-being: F = 33.557; trait anxiety: F = 14.875; all P < .001). These results point out that especially participants with worse initial levels of well-being and trait anxiety improved in the short and the long term.

Regression analyses

Regression analyses were conducted to examine the predictability of changes in well-being and trait anxiety by changes in PA, irrespective of condition (Table 2). Model 1 displays the abovementioned predictability by adjustment for several control variables, i.e. demographic variables (age, gender and marital status) and self-rated health at baseline. In model 2, perceived need-support of the coach at 10-WK FU was added to the set of predictor variables.

Self-rated health at baseline was 3.637 ± 0.609, 3.630 ± 0.675 and 3.593 ± 0.656 in REFER, WALK and COACH, respectively. Perceived health at baseline was not significantly different between the conditions (F = 0.195, P = .823). Perceived need-support of the coach after the intervention was 4.500 ± 0.416, 4.553 ± 0.408 and 4.635 ± 0.306 in REFER, WALK and COACH, respectively. Despite the relatively high score of need-support in each condition, significant differences were found between the conditions (F = 4.430, P = .012). More specifically, perceived need-support was significantly higher in COACH than in REFER (P = .003).

Well-being

The set of variables of model 1 and model 2 significantly predicted the changes in well-being. The variance in PA significantly contributed to this predictability, meaning that increased PA contributed to an increased level of well-being from pre- to follow-up-tests. Perceived need-support of the coach after the intervention additionally contributed to changes in well-being from pre-test to 10-WK FU and from pre-test to 1-YR FU. Furthermore, a lower baseline level of self-rated health, being married and being younger significantly contributed to larger improvements in well-being from pre-test to 10-WK FU, from pre-test to 1-YR FU and from pre-test to 2-YR FU, respectively.

Trait anxiety

With respect to trait anxiety, the proposed models significantly predicted changes in trait anxiety from pre-test to 1-YR FU, with changes in PA and perceived need-support at 10-WK FU (significantly) contributing to this predictability. Moreover, participants who were married tended to improve more in

trait anxiety from pre-test to 2-YR FU compared with those who were single (model 1: *β* = - .115, *P* = .058; model 2: *β* = - .106, *P* = .082).

Table 2. Regression analyses examining the predictability of pre- to ten-week follow-up-test, pre- to one-year follow-up-test and pre- to two-year follow-up-test changes in well-being and trait anxiety by changes in physical activity and need-support.

Well-being	Δprefu1		Δprefu2		Δprefu3	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
	β	*β*	*β*	*β*	*β*	*β*
PA (GLTE)	.114 *	.106 *	.199 ***	.178 **	.101 #	.096 #
Need-supp.		.143 **		.122 *		.083
F	3.415 **	4.183 ***	4.952 ***	5.139 ***	2.812 *	2.726 *
R^2	.043	.062	.075	.093	.044	.051

Trait anxiety	Δprefu1		Δprefu2		Δprefu3	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
	β	*β*	*β*	*β*	*β*	*β*
PA (GLTE)	- .069	- .067	- .161 **	- .137 *	- .022	- .020
Need-supp.		- 1.357		- .099 #		- .070
F	1.807	1.766	3.043 *	2.958 **	.800	.955
R^2	.023	.027	.047	.056	.013	.018

Note. PA (GLTE), self-reported physical activity score by Godin Leisure-Time Exercise Questionnaire; Need-supp., perceived need-support of the coach at ten-week follow-up-test; Δprefu1, change score from pre- to ten-week follow-up-test; Δprefu2, change score from pre- to one-year follow-up-test; Δprefu3, change score from pre- to two-year follow-up-test; Model 1: adjusted for age, gender, marital status, self-reported health at baseline; Model 2, model 1 plus perceived need-support of the coach at ten-week follow-up-test included as predictor variable; *, *P* < .05; **, *P* < .01; ***, *P* < .001; #, .05 < *P* < .092.

Discussion

This study compared the short- and long-term effects on subjective health of three PA counseling procedures among older adults: (1) a one-contact PA referral, (2) a one-contact provision of a structured walking program, and (3) a multiple-contact individually-tailored PA coaching based on SDT. Despite the inconsistent findings in the literature with respect to the effectiveness of PA promotion on various indicators of mental health[6, 10, 14, 16-17], improvements in well-being and trait anxiety were found shortly (i.e. ten weeks) after the beginning of the intervention in REFER, WALK and COACH. This finding suggests that various PA counseling procedures can be successful in increasing well-being and decreasing trait anxiety among older adults who are motivated to increase their PA. The finding that especially participants with worse initial levels of subjective health improved in well-being and trait anxiety can be explained by the occurrence of a ceiling effect. More specifically, participants who are already happy and satisfied with their life are less likely to further improve in subjective health and well-being.

In addition to the demonstrated effectiveness in the short term and even though PA interventions examining sustained effects on subjective health have produced inconsistent results[7, 15, 18, 22, 41, 59], this study

indicated positive effects of REFER, WALK and COACH on well-being and trait anxiety in the long term, i.e. one year after the intervention. In this respect, the results indicate that sustained PA promotion can be a potential strategy not only to maintain one's enhanced level of well-being but also to counteract the age-related decline in psychological health.[12, 60] However, two years after the intervention, the level of well-being and trait anxiety respectively decreased to and exceeded baseline levels. This finding indicates that the applied PA counseling strategies were insufficient to maintain enhanced levels of subjective health over a two-year follow-up period. Consequently, the implementation of booster sessions might be needed in order to maintain improved levels of subjective health. Moreover, other aspects than PA promotion are possibly essential to maintain satisfactory feelings of well-being and trait anxiety among older adults.

The demonstrated effectiveness of the PA programs on both well-being and trait anxiety is interesting. Even though these two constructs can be considered as indicators of subjective health, they involve diverse characteristics: (1) Well-being emphasizes the positive aspects of subjective health such as happiness whereas trait anxiety refers to stress-related emotions such as fear. Even though it has been stated that PA is especially effective in producing changes in indicators of a positive affective nature[12], the results of this study did not only demonstrate improvements in well-being but also in trait anxiety; (2) Trait anxiety is a clear indicator of psychological health whereas the applied measurement of subjective well-being comprises both a psychological and physical component. Given that physical fitness can be influenced directly by PA, we expected that well-being would improve more rapidly than trait anxiety. Moreover, because trait anxiety represents a more stable personality characteristic referring to how people feel 'in general', this construct is probably less likely to change shortly after PA has increased. However, the PA interventions did not only yield immediate changes in well-being but also in trait anxiety. Despite the abovementioned diversity between well-being and trait anxiety, the different PA programs have thus been shown to be successful in increasing positive emotions as well as in decreasing negative emotions among healthy older adults.

Contrary to our expectations, changes in well-being and trait anxiety were not significantly different between the three intervention conditions. The following two reasons might explain the lack of differences in changes in subjective health between REFER, WALK and COACH: (1) Each of the PA counseling strategies have been found to be effective in increasing PA[47], which in turn has been shown to yield improvements in subjective health[9-10]; and (2) Given that well-being is assumed to be enhanced by environmental factors facilitating the needs for autonomy, competence and relatedness[31], the similar changes in subjective health in all three intervention conditions suggest that not only WALK and COACH but also REFER was perceived as need-supportive. More specifically, in COACH, the Health Fitness Specialist explicitly fostered the three basic psychological needs outlined by SDT. In WALK, participants were explained a walking program with gradually increasing walking volume and intensity. Due to the structured format, the walking program was expected to evoke feelings of success and therefore to implicitly support participants' need for competence. Moreover, each of the participants was probably appreciative and pleased to take part in a scientific research. In this respect, participants of REFER might have perceived the

15-minute contact with the coach as need-supportive, even though this contact was not aimed to support the basic psychological needs. The abovementioned assumption is in accordance with the high rates of perceived need-support in all three interventions (i.e. 4.50 or more on a five-point Likert scale).

The demonstrated positive effects of need-supportive PA counseling on well-being and trait anxiety in this study are consistent with previous intervention studies that showed psychological benefits due to an autonomy-supportive exercise instructing style among (older) adults.[22, 38, 40] Similarly, qualitative research of Lloyd and Little[39] demonstrated improved levels of well-being through engagement in leisure-time PA in which SDT was supported. In this respect, Stathi et al.[32] emphasized that PA programs should meet older adults' personal needs, goals and preferences in order to obtain positive effects on well-being. The satisfaction of the basic psychological needs is thus not only associated with behavioral persistence (e.g., PA) but also with higher levels of subjective health and well-being.[31, 36-37, 61-62]

Even though mental health has been shown to be related to PA and perceived need-support, there is a lack of research studying the contribution of these two constructs to improved subjective health.[22, 24, 42] Identifying the determinants of health and well-being can be helpful to develop optimal health promoting strategies among older adults.[63] The results of the present study indicated that increases in PA as well as perceived need-support of the coach after a PA intervention significantly contribute to positive changes in well-being and trait anxiety. Need-supportive PA counseling can therefore be considered as an appropriate strategy to enhance subjective health among older adults. The close association between PA, perceived need-support and subjective health is reinforced by the significant correlations between those constructs. In addition, subsequent one-way ANOVAs underscored the importance of encouraging older adults to attain the PA health norm as prescribed by Haskell et al.[48] in order to improve their subjective health perception. More specifically, participants scoring 27 or more on the GLTEQ showed a significantly higher level of well-being and a lower level of trait anxiety compared with those who did not attain a GLTE-score of 27. According to Scheerder et al.[64], a score of 27 on the GLTEQ corresponds with the public health recommendation of 20 minutes of strenuous PA three times a week.

Notwithstanding the abovementioned significant contributions of changes in PA and need-support to changes in well-being, three comments should be made. First, consistent with previous findings in the literature, the explained variances were rather small.[42, 65] This suggests that, in addition to increased PA and perceived need-support, other factors are important to improve older adults' subjective health. Besides demographic variables such as age and marital status, research has identified the following determinants of quality of life and well-being in older adults: perceived health status, social reasons, individuals' personal goals and needs, leisure-time activities in general and activity-related enjoyment.[7, 13, 18, 60-61, 65-66] According to Everard[66], the low predictability of changes in well-being can also be attributed to the participants' sample, i.e. a homogenous group of relatively healthy community-dwelling older adults.

Second, the explained variances in well-being were larger than the explained variances in trait anxiety, meaning that changes in PA and perceived need-support contributed to a greater extent to changes in well-being than to changes in trait anxiety. This is in line with Diener et al.[26] who indicated that subjective

health is a multidimensional construct comprising indicators that can be influenced differently. On the one hand, the applied measurement of well-being involved a psychological as well as a physical component. Physical well-being does not only refer to the avoidance of diseases but also addresses the experience of a good health, the increase in physical fitness, the satisfaction with one's body and the ability to perform habitual tasks without effort.[9, 61] These physical aspects of well-being are probably affected relatively easily by changes in PA. This is in accordance with Rejeski et al.[41] who stated that functional changes are the most direct and salient effects experienced through the involvement in PA programs. Similarly, Stathi et al.[9] indicated the direct effect of PA on physical well-being. On the other hand, trait anxiety refers to a general tendency to respond anxiously to perceived environmental threats, and accordingly reflects a more stable dimension of subjective health. Therefore, trait anxiety is less likely to be influenced directly and to a large extent by changes in PA.[20] Moreover, given that a significant contribution of changes in PA to changes in trait anxiety could only be indicated in the long term, i.e. one year after the intervention, (older) individuals might need more time to perceive the psychological benefits associated with PA than the physical benefits associated with PA.

Third, despite the significant contribution of changes in PA to changes in subjective health from pre-test to 1-YR FU, the prediction is less clear from pre-test to 2-YR FU with respect to well-being and even disappears with respect to trait anxiety. Moreover, after a two-year follow-up period, perceived need-support of the coach does not longer contribute to the changes in subjective health. Given that PA further increased from pre-test to 2-YR FU, other factors such as age and changes in participants' social environment might have led to the decreases in well-being and increases in anxiety. Moreover, the current findings suggest that coaches should continue fostering the needs for autonomy, competence and relatedness in order to maintain high levels of subjective health.

Despite the rather low predictability of changes in subjective health by changes in PA and perceived need-support, these results point out the importance of motivating individuals to increase their PA level, of stimulating coaches to facilitate their clients' needs for autonomy, competence and relatedness, and of encouraging policy makers to support the implementation of (SDT-based) PA interventions in order to obtain subjective health benefits at community level.[41] However, prior to implement health promoting strategies in the wider community, their cost-effectiveness should be considered. In this respect, REFER and WALK are one-contact PA counseling procedures whereas COACH involves a multiple-contact and thus more time-consuming procedure. Moreover, given that the PA counseling associated with REFER and WALK is not individually-tailored, this counseling can take place at group level (e.g., in a socio-cultural organization). Consequently, health promoting strategies such as REFER and WALK might be more beneficial to implement at a large scale than multiple-contact individually-tailored coaching, especially in a context of limited resources. In addition to this lifestyle approach that aims to improve individuals' well-being through an increase of their PA level, structural environmental changes may also increase individuals' PA level and subsequently enhance public health. For example, given the favorable climate in Belgium and more

specifically in Flanders, building safe bicycle and footpaths may be helpful to promote active transportation among the Flemish population.

Before concluding, several strengths and limitations should be noted. The use of a longitudinal study design constitutes a first strength. This allowed us to examine causality rather than studying merely cross-sectional associations between PA, need-support and psychological responses. Moreover, the assessment of well-being and trait anxiety one year and two years after the intervention provided information on the sustainability of the effects of the different PA programs on mental health. Second, given that well-being is associated with PA on the one hand and with need-support on the other hand, the extent to which both constructs contribute to the prediction of well-being was studied. This enabled us to gain insight in the mechanisms leading to improved psychological health. Third, by studying the PA effects on well-being (i.e. a positive indicator of subjective health, comprising physical and psychological well-being) as well as on trait anxiety (i.e. a negative indicator of subjective health, considered as a relatively stable individual characteristic), subjective health was approached as a multidimensional construct.

The lack of a strict control condition constitutes a first limitation. This prevented us from drawing strong conclusions on the impact of the PA programs relative to participation effects. However, the demonstrated year-round improvements in well-being and trait anxiety suggest that the PA interventions considerably contributed to the increases in subjective health. Due to the health promoting character of the study and the voluntary participation of the older adults, we considered it more ethical to include a minimal PA counseling procedure rather than a no-treatment condition. A second limitation refers to the generalization of the study results. Recruitment occurred through media campaigns which involve voluntary study participation. Consequently, the sample consisted of sedentary but relatively healthy and highly educated older adults who were initially already motivated to increase their PA, and thus to improve their health. This self-selection recruitment procedure reduces the generalizability of the findings to (younger) adults who are less motivated, have less education and are in poorer health. Third, measurements were based on self-reports, which may have led to overestimation and social desirability. However, compared with objective health indices, subjective measures of health have been shown to be more strongly related to outcomes such as life satisfaction.[13] Finally, given that dropouts were significantly different from non-dropouts with respect to age, marital status and self-rated health at baseline, there might have occurred some attrition bias on the observed study results. However, neither baseline levels of well-being and trait anxiety (i.e. the criterion variables) nor baseline levels of PA were significantly different between dropouts and non-dropouts.

To conclude, this study provides evidence for the year-round effectiveness of multiple (need-supportive) PA programs on well-being and trait anxiety among older adults, especially among those with initially lower levels of mental health. In addition to enjoyment and a meaningful social environment, the results indicate the importance of increased PA and a sufficient level of perceived need-support in order to maintain satisfactory feelings of mental health and well-being in this population over a one-year follow-up period. However, the lack of beneficial effects of the PA counseling procedures on well-being and trait

anxiety over a two-year follow-up period points out that the applied PA promoting strategies were inappropriate to maintain enhanced levels of mental health in the long term. The absence of differences in associations between REFER, WALK and COACH and the indicators of mental health suggests that both one-contact PA counseling and more time-consuming need-supportive coaching are valuable health promoting strategies among older adults. Given that a PA referral and the provision of a walking program only involve a single advice session, these counseling strategies entail relatively low costs and are therefore particularly beneficial to implement at a large scale compared with multiple-contact PA coaching. This study constitutes a promising step in the development and implementation of cost-effective health promoting strategies in the wider community.

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Endnote

The term 'sedentary' refers to 'not attaining the PA recommendations for health as prescribed by Haskell et al. (2007)', i.e. in addition to performing daily activities that last less than ten minutes or that are of mild intensity, accumulating at least moderate intensity aerobic PA for a minimum of 30 minutes on five days each week, in bouts of at least ten minutes, or strenuous intensity aerobic PA for a minimum of 20 minutes on three days each week, or a combination of moderate and strenuous intensity aerobic PA.

The intervention effects on PA are explained in detail in Van Hoecke and colleagues.[47] Below, we provide a short description of the intervention effects on self-reported PA, paying especially attention to the effects at 2-YR FU.

Self-reported PA at pre-test did not significantly differ between the conditions (F = 2.283, P = .103). However, mixed model analyses indicated a significant difference in change over time between the conditions (P = .039) (Table 3; Figure 3). Furthermore, a main (4) time effect was found (P < .001), indicating an overall change in self-reported PA across the conditions. More specifically, overall significant changes were found in all three interventions (REFER: F = 30.447; WALK: F = 60.626; COACH: F = 101.695; all P < .001).

Contrast estimates showed significant differences in pre-test to 10-WK FU changes of self-reported PA between REFER on the one hand and WALK (t = 2.674, P = .008) and COACH on the other hand (t = 2.254, P = .025). Nevertheless, all three conditions significantly increased in self-reported PA from pre-test to 10-WK FU (REFER: 95% CI = - 12.026 to - 7.065; WALK: 95% CI = - 17.672 to -11.754; COACH: 95% CI = - 16.521 to - 11.369; all P < .001). At 10-WK FU, one-way ANOVAs indicated (borderline) significant differences between the conditions with respect to self-reported PA. More specifically, WALK showed significantly higher PA levels than REFER (F = 2.937, P = .054; WALK>REFER, P = .019).

From 10-WK FU to 1-YR FU, self-reported PA further increased (95% CI = - 6.611 to - 2.715, P < .001), with no significantly different changes between the conditions. Consequently, all three conditions

significantly increased in self-reported PA from pre-test to 1-YR FU (overall: 95% CI = - 19.209 to - 15.618; REFER: 95% CI = - 17.173 to - 9.800; WALK: 95% CI = - 21.728 to -15.424; COACH: 95% CI = - 22.434 to - 17.520; all $P < .001$). However, larger increases emerged in WALK and COACH compared with REFER (respectively, $t = 2.205$, $P = .028$ and $t = 2.893$, $P = .004$). No significant differences in PA were found between the three conditions at 1-YR FU ($F = 2.138$, $P = .120$).

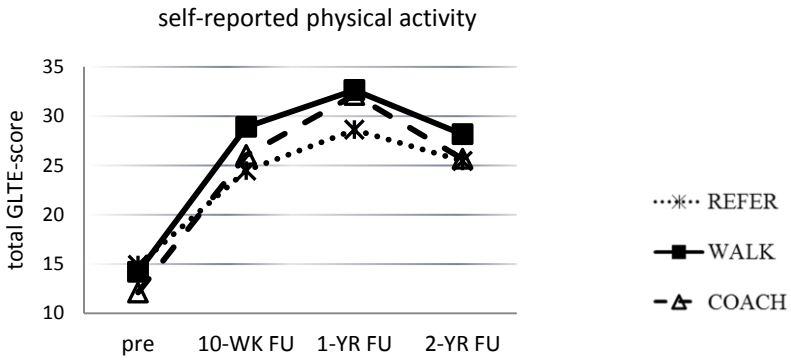
From 1-YR FU to 2-YR FU, PA relapsed to the level at 10-WK FU (95% CI = 2.723 to 6.689, $P < .001$), with no significantly different changes between the conditions. However, self-reported PA still increased from pre-test to 2-YR FU in all three conditions (overall: 95% CI = - 14.471 to - 10.933; REFER: 95% CI = - 13.768 to - 7.393; WALK: 95% CI = - 17.132 to -10.800; COACH: 95% CI = - 16.412 to - 10.707; all $P < .001$). Pre- to 2-YR FU-test changes in self-reported PA did not significantly differ between the conditions. No significant differences in PA were found between the three conditions at 2-YR FU ($F = 0.932$, $P = .395$).

Table 3. Estimated means (SE) at pre-test, pre- to ten-week follow-up-test, pre- to one-year follow-up-test and pre- to two-year follow-up-test change scores for self-reported PA in REFER, WALK and COACH, 4 (time) x 3 (conditions) interaction effects and (4) time effects for PA.

	REFER	WALK	COACH	4 x 3 interaction	Time
	Mean (SE)	Mean (SE)	Mean (SE)	*F*	*F*
Self-reported PA (GLTE)					
Pre	14.883	14.195	12.099		
	(0.956)	(0.960)	(0.956)		
Δprefu1	+ 9.614	+ 14.710	+ 13.968		
	(1.259)	(1.247)	(1.287)	2.247 *	165.632 ***
Δprefu2	+ 13.617	+ 18.605	+ 20.020		
	(1.508)	(1.549)	(1.478)		
Δprefu3	+ 10.568	+ 13.975	+ 13.563		
	(1.495)	(1.486)	(1.539)		

Note. SE, standard error; PA, physical activity; REFER, PA referral condition; WALK, walking condition; COACH, individually-tailored need-supportive coaching condition; Pre, pre-test value; Δprefu1, change score from pre- to ten-week follow-up-test; Δprefu2, change score from pre- to one-year follow-up-test; Δprefu3, change score from pre- to two-year follow-up-test; 4 x 3 interaction, interaction effect over (4) time and between (3) conditions; Time, overall time effect over the conditions; GLTE, overall PA score score measured by the Godin Leisure-Time Exercise Questionnaire; *, $P < .05$; ***, $P < .001$.

Figure 3. Changes over time in self-reported physical activity.



REFER, physical activity referral condition; WALK, walking condition; COACH, individually-tailored need-supportive physical activity condition; total GLTE-score, total physical activity score on the Godin Leisure-Time Exercise Questionnaire; pre, score at pre-test; 10-WK FU, score at ten-week follow-up-test; 1-YR FU, score at one-year follow-up-test; 2-YR FU, score at two-year follow-up-test.

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Part 4

Physical activity promotion based on the Self-Categorization Theory among insufficiently active older adults

CHAPTER 4.1

The long reach of identity-based physical activity promotion: A comparative effectiveness study among insufficiently active older adults

Ann-Sophie Van Hoecke, Norbert Vanbeselaere, Filip Boen

Submitted

Note. Chapter 4.1 of this doctoral thesis is split up into (1) a results and discussion section related to the effects of the identity-based physical activity interventions on physical activity, and (2) a results and discussion section related to the effects of the identity-based physical activity interventions on subjective health and well-being. However, the submission of the article entitled 'The long reach of identity-based physical activity promotion: A comparative effectiveness study among sedentary older adults' was limited to the results and discussion related to physical activity.

Abstract

Besides supporting individuals' personal needs, emphasizing their social identity has been assumed to facilitate behavioral change and to positively affect their health. Therefore, the aim of this study was to compare the year-round effects of personally-oriented and socially-oriented physical activity (PA) counseling on PA and well-being among Flemish older adults.

Adults aged 55 to 70 years who did not attain the physical activity recommendations for health (n = 169) were randomized to three identity-based PA promoting interventions: (1) A personal identity condition (PI) in which participants' personal self was targeted during counseling based on the Self-Determination Theory. A Health Fitness Specialist fostered the needs for autonomy, competence and relatedness at the personal level of the self; (2) A social identity condition (SI) in which participants' social self was targeted during counseling based on the Self-Categorization Theory. A Health Fitness Specialist postulated social identity-based normative support for PA; and (3) A joined identity condition (JI) in which participants' personal and social self were targeted. Participants completed measurements on PA (i.e. pedometer-based steps, pedometer-based aerobic minutes, self-reported PA), health (i.e. self-rated health, physical well-being, psychological well-being) and various predictor variables before (baseline), immediately after (6-WK FU) and one year after (1-YR FU) the six-week intervention.

With respect to PA, mixed models showed significant increases in pedometer-based and self-reported PA from baseline to 6-WK FU and from baseline to 1-YR FU, with no differences in changes over time between the conditions. The effects of perceived need-support and perceived normative support on daily steps were mediated by identified regulation and integrated regulation, respectively.

With respect to health, self-rated health significantly increased in SI and JI from baseline to 6-WK FU and from baseline to 1-YR FU whereas no changes occurred in PI. Physical well-being significantly increased in JI from baseline to 6-WK FU and from baseline to 1-YR FU whereas no changes emerged in PI and SI. Finally, psychological well-being significantly increased in JI from baseline to 6-WK FU whereas no changes emerged in PI and SI. Participants' daily steps and their degree of identification with relevant social identities were significantly related to their subjective health.

Targeting older adults' personal or / and social self appear to be equally effective in promoting their PA in the long term. Moreover, the findings point out the importance of highly qualitative behavioral regulation, either identified or integrated, to perform PA behavior. With respect to older adults' subjective health and well-being, a social identity-based approach seems to be essential to yield improvements. In this respect, individuals' membership of a meaningful group can positively affect their health perception.

Keywords: physical activity, well-being, older adults, Self-Determination Theory, Self-Categorization Theory, need-support, social identity, comparative effectiveness research, longitudinal intervention

Introduction

The increasing life expectancy in Western societies yields a continuously growing proportion of older adults [1]. Given that advanced age is associated with a higher prevalence of chronic diseases, disabilities and impaired functioning, the ageing of the world's population results in a substantial burden from both a health and an economic perspective [2]. Regular physical activity (PA) has been recognized as a crucial component of a healthy lifestyle and as an important determinant of healthy ageing [3-5]. Nevertheless, only half of the Western population attains the recommended PA level for health [6-8]. Moreover, PA behavior has been found to decline with age and can be negatively affected by transitional life stages such as retirement [8-10]. PA promotion has therefore emerged as a public health priority, especially for people in the late adulthood and for older adults.

Previous research among adults aged 50 years or older has demonstrated the short-term effectiveness of various PA promoting strategies, including group-based exercise sessions, individually-tailored PA counseling, walking programs at community level and non-endurance physical activities [4,11-14]. However, evidence for the long-term effectiveness of health promoting strategies is limited [4,11,13].

According to the literature on PA promotion, the following three aspects should be provided in order to produce PA behavior in the long term: (1) a theoretical foundation for the applied counseling strategy, (2) support for participants' personal needs, and (3) an ongoing follow-up to participants after the intervention period [4,11,15-20]. In this respect, the Self-Determination Theory (SDT) [21] has been proposed as an appropriate framework for interventions that aim to facilitate health behavior changes such as PA engagement. Moreover, SDT has been considered as especially relevant among the older adult population because ageing may involve feelings of reduced personal control and competence [15].

Self-Determination Theory

SDT postulates that each individual possesses three inherent psychological needs that are essential for optimal growth, development and well-being, i.e. the need for autonomy, the need for competence and the need for relatedness [22]. The need for autonomy reflects individuals' desire to experience volition and to feel a sense of willingness and choice when acting. The need for competence refers to individuals' pursuit of mastering a task within a challenging environment and to feel a sense of efficacy. The need for relatedness concerns individuals' tendency to interact with, to connect to and to feel a sense of belongingness with others [22,23]. The satisfaction of these three needs is hypothesized to positively affect individuals' cognitive functioning and well-being as well as to facilitate their behavioral change [15,20,21,23-26]. More specifically, it is assumed that the more individuals' social environment supports their basic psychological needs, the more their regulation to perform a behavior will be self-determined (i.e. autonomous) [23].

SDT proposes different forms of behavioral regulation, which can be situated along a motivational continuum. This continuum ranges from regulation that is controlled by external or internal reinforcements to regulation that is self-endorsed and personally valued, and therefore volitional and autonomous. Intrinsic

motivation occupies the most self-determined end of the continuum and refers to the performance of a behavior for reasons of interest, enjoyment or challenge. Identified regulation and integrated regulation are two forms of motivation that involve behavior that is or from which the outcome is personally valued. Even though these types of motivation reflect behavioral engagement for instrumental reasons rather than for its inherent satisfaction, they can still be considered as self-determined forms [20]. More specifically, identified regulation reflects behavior that is guided by self-endorsed commitments or by the personal importance and meaningfulness of the (outcome produced by the) activity. For example, individuals who engage in running in order to lose weight demonstrate identified regulation. Integrated regulation, which is a more autonomous form of motivation than identified regulation, refers to behavior that is performed because of its assimilation with (other values and needs that are associated with) individual's personality and identity. For example, individuals demonstrate integrated regulation when they engage in running because they identify themselves with runners or when they use the elevator instead of climbing the stairs because they identify themselves with old persons. The important point is that the more individuals' behavioral regulation is autonomous, the more effort they are likely to put in that behavior, and consequently the more the behavior is assumed to persist in the long term [21,25].

Previous research on need-supportive PA counseling has provided empirical evidence that SDT is a valuable framework to facilitate health promoting behavior such as PA [20]. For example, Silva and colleagues [18] observed an increase in PA among pre-menopausal overweight women who had participated in a year-round behavior change program based on SDT whereas no changes were found in a control group receiving general health education. Moreover, consistent with SDT-grounded assumptions, Fortier et al. [27] found that autonomous motivation and perceived competence support significantly predicted PA among patients receiving autonomy-supportive counseling.

By distinguishing between its different types, behavioral motivation is defined in terms of its quality (determined by the 'why'). As suggested above, the more individuals' behavior is autonomously regulated, the higher the quality of their motivation and the greater their behavioral persistence. However, motivation should not only be described in terms of its quality but also in terms of its quantity. Quantity of motivation refers to the amount of drive or desire that individuals have towards a task, and thus to their strength of motivation (i.e. 'how much') [28]. Similar to the quality of motivation, quantity of motivation has been demonstrated to positively affect individuals' PA behavior [28].

Inconsistency with respect to behavioral maintenance

As suggested above, SDT has been shown to be an effective framework to promote and understand PA. However, despite the assumption that need-supportive counseling yields sustained behavioral changes, most of the previous SDT-based studies have been cross-sectional [20]. Moreover, studies that applied a longitudinal design have shown inconsistent effects in the long term, i.e. six months or more after the intervention [20].

Below, we propose two theoretical considerations that might explain the inconclusive results of need-supportive counseling on behavioral maintenance:

(1) As hypothesized by SDT, motivation is a crucial determinant of sustained PA behavior [20]. In particular, individuals should express a sense of self-endorsement and willingness in order to be autonomously motivated, and accordingly maintain their PA. Despite the existence of three types of autonomous motivation, most SDT-based studies have focused on the role of identified regulation or the role of intrinsic motivation on individuals' behavior but have typically neglected the role of integrated regulation [20,29-31]. Nevertheless, integrated regulation has also been shown to be an important determinant of PA behavior, in particular of its frequency and duration [15,20,29-31]. Furthermore, given that sustained PA participation is associated with a high degree of effort, organization and commitment, it is argued that the internalization of the value of outcomes is more important and even more likely to yield behavioral persistence than being intrinsically motivated [20,32-34]. Therefore, and considering that integrated regulation is a more autonomous form of motivation than identified regulation, counseling strategies that explicitly focus on PA engagement as part of individuals' identity might be more effective in promoting sustained PA behavior than counseling strategies that focus on PA engagement because of the meaningful outcome of PA or because of the enjoyment that is associated with PA;

(2) According to SDT, a social environment providing support for individuals' needs for autonomy, competence and relatedness is assumed to improve their well-being as well as to yield more internalized behavioral regulation, better performances and more behavioral persistence [35]. Even though SDT points out the importance of each of the three psychological needs to enhance individuals' health (behavior), SDT-grounded interventions have mainly focused on fostering the need for autonomy (e.g., by supporting individuals' choices) and the need for competence (e.g., by providing positive feedback) [20]. By contrast, the need for relatedness has been studied to a lesser extent within need-supportive PA promotion. Nevertheless, previous research has demonstrated a positive relationship between perceived relatedness support and social support on the one hand and PA behavior on the other hand [20,30,36]. Feeling a sense of connectedness has thus been shown to be important to adopt and maintain PA, even though it is stated that relatedness support is a less proximal determinant of behavioral regulation than autonomy and competence support [37]. In addition, despite the strong correlation between the three basic needs and the finding that supporting only one psychological need can be sufficient to yield positive outcomes [35,38-40], providing support for all three needs has been indicated to produce greater behavioral engagement and persistence than supporting only one or two needs [32,35,41]. In this respect, Hagger and Chatzisarantis [42] stated that the gratification of all three needs, including the need for

relatedness, is required to obtain optimal functioning and full internalization of behavioral processes.

Furthermore, need-supportive interventions that did aim to foster the need for relatedness have mainly focused on its interpersonal component, e.g. by creating an empathetic connection with the client or by showing unconditional regard [20]. However, social psychological theories such as the Self-Categorization Theory (SCT) [43] underscore the importance of defining one's sense of self not just in personal terms but also in social terms, i.e. in terms of one's group memberships [44,45]. More specifically, relatedness support at the group level is proposed as a crucial antecedent for behavioral change, and especially for health behavior. Consequently, PA counseling strategies focusing on individuals' social level of the self might therefore be effective in promoting long-term PA behavior.

Self-Categorization Theory

The Social Identity Approach embraces two related social psychological theories, i.e. Social Identity Theory (SIT) [46] and SCT [43]. SIT describes the cognitive and motivational basis of intergroup differentiation and was initially developed to explain individuals' behavior relating to intergroup conflict and discrimination [47,48]. SCT is an extension of SIT and is developed to explain behavior in terms of social identification and individuals' cognitive process of self-categorization [45,49]. Both theoretical frameworks assume that individuals can define themselves at the personal and at the group level [50]; By perceiving themselves as belonging to various social groups (e.g., older adults, physically active persons), individuals can understand their social environment in a more meaningful way [51,52]. However, while SIT particularly emphasizes that group memberships influence individuals' sense of self, SCT elaborates on this idea by postulating that there are three levels at which individuals can define themselves: (1) the subordinate level, meaning that individuals categorize themselves as individuals compared to other individuals, and thus in terms of their personal identity; (2) the intermediate level, meaning that individuals categorize themselves as members of a (in-) group compared to a relevant (out-) group, and thus in terms of their social identity. This level consists of sublevels, e.g. an individual can categorize him / herself as a scientist, as a psychologist or as a social psychologist; and (3) the superordinate level, meaning that individuals categorize themselves as human beings compared to other species, and thus in terms of their human identity [43,45].

The level at which individuals categorize themselves does vary according to the particular context and might affect their cognitions and behaviors [43,46,47,50,53]. More specifically, by defining themselves in terms of their personal identity, individuals' feelings and actions are determined by their personal characteristics and motivations. Accordingly, individuals understand themselves in terms of their unique characteristics that are not shared with others (i.e. 'me' versus 'you'). On the other hand, by defining themselves in terms of their social identity, individuals' feelings and actions are determined by group-related characteristics. Accordingly, individuals evaluate themselves in the same way as other members of

their group and all group members relate in an identical manner to individuals who are a member of the outgroup (i.e. 'us' versus 'them') [48].

The essence of group membership is a shared social identification, which is cognitively represented as a group prototype, i.e. a subjective set of beliefs, perceptions, attitudes, feelings and behaviors that are related to each other in a meaningful way [47,48,53]. Individuals who identify strongly with a group are assumed to adopt the group prototype, and accordingly to behave in accordance with the norms and values that are relevant to that group identity [54-56]. For example, individuals who identify themselves with old persons will probably use the elevator instead of climbing the stairs, individuals who identify themselves with business people will probably wear a suit instead of a sweater, individuals who identify themselves with cyclists will probably engage in cycling and join a cyclists' association, and individuals who identify themselves with socially engaged persons will probably be socially committed, involved in volunteering or social work, and worried about others' well-being.

Previous research has provided evidence for the positive influence of social identification, social categorization and group norms on health behavior change such as PA engagement [49]. For example, Renger, Steinfelt, and Lazarus [57] showed that a media campaign in which local community members promoted positive PA norms directly affected the PA behavior of other community members who identified strongly with the 'community identity'. Similarly, identity-based studies have demonstrated that the perceived normative support of a relevant reference group (e.g., student identity) influenced individuals' intentions to engage in regular PA [50,55,58-62].

In addition to facilitating behavioral changes, group membership and being embedded in a social network are assumed to positively impact on individuals' health and well-being [45]. More specifically, it is hypothesized that individuals who categorize themselves with a group that provides stability, meaning, purpose and direction, will enhance their mental health, self-esteem, self-worth and cognitive functioning [49,51,63].

Rationale and aim of the present study

As outlined above, providing individualized need-support and postulating positive social norms have both been demonstrated to facilitate PA adoption. However, to our knowledge, no studies have compared the effectiveness of an SDT-approach and an SCT-approach within the domain of PA promotion, neither in the short term nor in the long term. Nevertheless, SCT-based counseling is assumed to target individuals' relatedness at the group level (i.e. through identification with a particular social group), and accordingly to facilitate their PA engagement because of the assimilation of this behavior with their identity (i.e. through integrated regulation). In this respect, SCT might provide an answer to the abovementioned considerations with respect to the inconsistent effects of SDT-based counseling upon the maintenance of PA, and might therefore be a more effective framework than SDT for the promotion of PA, especially in the long term.

Based on this reasoning, we conducted a comparative effectiveness study in which we examined the effectiveness of PA promoting interventions that targeted different levels of older adults' sense of self. In general, comparative effectiveness research aims at evaluating and comparing health outcomes and the clinical effectiveness, risks and benefits of two or more (medical) treatments or services [64]. In addition, this type of research does not only focus on the effectiveness of health-enhancing strategies but also on their efficiency, and accordingly supports policy makers to make informed decisions on the large-scale implementation of cost-effective PA and health promoting strategies [64].

In particular, a comparative effectiveness study was implemented in which we, at first, compared the short-term (i.e. immediately after the study) and long-term (i.e. one year after the study) effects on (1) PA and on (2) subjective health of three identity-based PA counseling strategies among adults aged 55 to 70 years. The first counseling strategy (i.e. personal identity condition; PI) consisted of a need-supportive PA coaching based on SDT in which participants' personal identity was targeted. During weekly contact, a Health Fitness Specialist (HFS) supported participants' needs for autonomy, competence and relatedness at the personal level of the self. The second counseling procedure (i.e. social identity condition; SI) comprised a PA promoting strategy based on SCT in which participants' social self was targeted. During weekly contact, a HFS provided social identity-based normative support for PA, and in particular for walking. More specifically, walking behavior was proposed as prototypical for a relevant reference group within this population. Based on the results of a preliminary survey (which will be briefly described previous to the comparative effectiveness study), 'socially engaged persons' and 'independent persons' were considered as the most appropriate reference groups to be used in the PA intervention. The third PA promoting strategy (i.e. joined identity condition; JI) embraced a PA counseling in which a HFS facilitated participants' PA behavior by targeting their personal and social self during weekly contact. This counseling method combined the counseling procedures applied in PI and SI.

The second purpose of this study was to test whether the intervention effects on PA and on subjective health could be explained by the processes proposed by SDT and SCT. With respect to PA, we evaluated the mediating role of identified regulation on the relationship between perceived need-support and PA, as proposed by SDT. Moreover, we evaluated the mediating role of integrated regulation on the relationship between perceived normative support for PA and PA behavior, as proposed by SCT. With respect to health, we evaluated the extent to which participants' PA level, their perceived need-support and their degree of identification with relevant social identities were related to their self-rated health, physical well-being and psychological well-being.

The hypotheses related to PA are formulated below. They are split up into hypotheses related to the intervention effects on PA and hypotheses related to the underlying processes.

- First of all, we expected that (pedometer-based and self-reported) PA would increase in each of the intervention conditions, both in the short and in the long term (*Hypothesis 1a; H1a*).

However, we expected larger increases in SI and JI than in PI because a more autonomous, and thus more qualitative, form of motivation would be more strongly aroused in SI and JI than in PI (i.e. integrated regulation versus identified regulation) (*Hypothesis 1b; H1b*).

Moreover, we expected the largest PA increases in JI (*Hypothesis 1c; H1c*) because of the following three reasons: (1) Both identified regulation and integrated regulation were fostered in JI, which would probably yield a higher level (i.e. more quantity) of motivational regulation to engage in PA, and therefore larger PA increases in JI than in PI and SI; (2) Not only the personal self but also the social self was targeted in JI whereas PI and SI each focused on only one level of the self; and (3) The counseling strategy of JI was based on a combination of SDT-based and SCT-based constructs, which is assumed to yield larger effects than when a counseling strategy is based on a single theoretical framework [16].

- In *Hypothesis 2*, we expected that, consistent with SDT, higher levels of perceived need-support would be associated with higher levels of PA through higher levels of identified regulation, irrespective of intervention condition (*Hypothesis 2a; H2a*).

  Consistent with SCT, we expected that higher levels of perceived normative support for PA would be associated with higher levels of PA through higher levels of integrated regulation, irrespective of intervention condition (*Hypothesis 2b; H2b*).

The hypotheses related to health are formulated below. They are split up into hypotheses related to the intervention effects on health and hypotheses related to the underlying processes.

- In *Hypothesis 3*, we expected improvements in subjective health, physical well-being and psychological well-being in each of the intervention conditions, both in the short and in the long term (*Hypothesis 3a; H3a*).

  However, we expected larger improvements in JI than in PI and SI (*Hypothesis 3b; H3b*). This would be consistent with the theoretical assumptions of SDT and SCT stating that, respectively, supporting individuals' needs at the personal level and emphasizing their relatedness at the social level can positively affect their health.
- In *Hypothesis 4*, we expected that a higher level of PA (*Hypothesis 4a; H4a*), a higher level of perceived need-support (*Hypothesis 4b; H4b*) and a higher degree of identification with relevant social identities (*Hypothesis 4c; H4c*) would be be related to higher levels of health and well-being.

Preliminary survey

Procedure

An intervention at the social level of the self can only affect individuals' behavior if the postulated subjective norms emanate from a behaviorally relevant reference group [50]. Hence, prior to implementing a socially-oriented PA promoting intervention, a web-based survey was designed to identify meaningful

social identities among Flemish adults aged 55 to 70 years. Recruitment occurred through advertisements in local newspapers, internet-based announcements and approximately 12 000 pamphlets spread via physicians, pharmacists and socio-cultural organizations. The advertisements provided information on the aim of the survey, i.e. determining important characteristics of older adults in order to optimize health campaigns, and a digital link to the survey.

The survey proposed four personality-based (i.e. being socially engaged, being dedicated, being independent, being a life enjoyer) and two role-based (i.e. being a grandparent, being a life partner) self-characteristics that were selected from literature [15,65-68]. Participants (n = 1340) were asked for their degree of identification (four items; modified version of Exercise Identity Scale [69]), the group formation potential (two items) [70,71] and the (injunctive and conjunctive) norms for PA (two items) with respect to each of the six social identities.

Results and discussion

Two social identities that were proposed in the preliminary survey were selected for the PA intervention: (1) the identity of socially engaged individuals (SOC), referring to individuals who are socially committed, involved in volunteering or social work or worried about others' health and well-being; and (2) the identity of independent individuals (IND), referring to individuals who attach great importance to being self-employed, autonomous and functionally independent. The selection of SOC and IND for the PA intervention was based on three reasons:

(1) The group formation potential of SOC and IND was respectively 4.87 ± 1.21 and 5.06 ± 1.18, measured on a seven-point Likert scale ranging from '1 = completely disagree' to '7 = completely agree'. More specifically, participants who identified themselves with SOC / IND perceived themselves as similar to individuals who share the particular self-characteristic but as different from individuals who do not share the particular characteristic. The personality-based self-characteristics showed a significantly higher group formation potential than the role-based characteristics (personality-based: 5.04 ± 0.99; role-based: 4.29 ± 1.18; $t = 22.689$, $p < .001$). This finding is consistent with Thoits and Virshup's [72] statement that a perception of similarities in beliefs and behaviors may be a stronger basis for collective identification than role-based similarities [68];

(2) The subjective norms for PA were 5.92 ± 1.26 with respect to SOC and 6.04 ± 1.18 with respect to IND, measured on a seven-point Likert scale ranging from '1 = completely disagree' to '7 = completely agree'. More specifically, respectively 85.8% and 87.6% of the participants were of the opinion that socially engaged and independent persons (should) engage in PA at a regular basis, i.e. indicated a score of five or more on the seven-point Likert scale. In addition to this strongly perceived identity-based support for PA at the time of measurements, PA is a positively valued behavior that can easily be postulated as normative for SOC and IND. For example, PA engagement might fit the prototype of SOC and IND because of its social

character and its physical aspects, respectively. Accordingly, providing identity-based normative support for PA among socially engaged and independent persons can be a potential strategy to increase the number of Flemish older adults attaining the PA health recommendation as prescribed by Haskell and colleagues [7,8];

(3) According to the Social Identity Approach [46], individuals tend to obtain a positive social identity by balancing between two social needs, i.e. the need to positively differentiate (referring to competence) and the need to behave in a fair way (referring to warmth) [73-75]. In particular, members of a social group that is stereotyped as less competent than another group will claim dominance on the warmth dimension in order to obtain a positive social identity, and vice versa. Given the inherent characteristics of SOC and IND, individuals defining themselves in terms of SOC can be stereotyped as less competent but warm whereas individuals defining themselves in terms of IND can be stereotyped as less warm but competent. Consequently, by applying both SOC and IND in the PA intervention, the results of the comparative effectiveness study will provide information on the potential generalization of identity-based PA promotion to a variety of relevant social identities within this population group.

Comparative effectiveness study

Methods

Recruitment and participants

A flow chart of the randomized trial is presented in Figure 1. Participants of the PA intervention were recruited out of the pool of participants of the preliminary survey. The following three inclusion criteria were employed: (1) identifying oneself sufficiently with SOC or / and IND, i.e. obtaining a mean score of five or more on the seven-point Likert scale; (2) top-three ranking of SOC or / and IND, i.e. considering the particular social identity as one's most, second most or third most important self-characteristic; and (3) not attaining the PA health recommendation of 30 minutes of moderate intensity PA on five days a week or 20 minutes of strenuous intensity PA three times a week [7]. In total, 526 participants of the preliminary survey met the inclusion criteria and were invited to participate in the health-oriented intervention by means of a personal email. One hundred and sixty-nine persons volunteered to participate in the PA counseling. The PA intervention was performed simultaneously in a SOC branch and an IND branch. The study was approved by the Ethical Committee of the KU Leuven.

Procedure

Figure 2 provides a build-up of the intervention procedure. Prior to attending a locally-organized intake session with a HFS (MSc) (i.e. participants' coach during the PA program; n = 1), participants were randomly assigned to three six-week PA intervention conditions: (1) a personal identity condition (PI), i.e. a

PA counseling procedure based on SDT, and targeting participants' personal self (n = 56); (2) a social identity condition (SI), i.e. a PA counseling procedure based on SCT, and targeting participants' social self (n = 57); and (3) a joined identity condition (JI), i.e. a PA counseling procedure based on SDT and SCT, and targeting participants' personal and social self (n = 56). Dependent upon organizational regulations, the face-to-face intake session took place individually or in groups of two to four participants who were allocated to the same identity branch and the same intervention condition. During this first contact (which lasted for approximately one hour), the study purpose and procedures were explained, participants gave their written consent and baseline measurements were completed. Furthermore, the coach elaborated on the continuous ageing of the population, the age-related physical changes and increased risk of health diseases, the PA health benefits and the current PA recommendations for health.

Subsequently, a similar counseling procedure was implemented in each of the intervention conditions in order to support the participants to attain the recommended PA level for health as prescribed by Haskell et al. [7]. More specifically, a weekly contact between coach and participant took place, either face-to-face (one time, i.e. immediately after the intake session, lasting for approximately one hour), by means of an email conversation (three times) or by means of a post card with striking photographs or catch phrases (two times). Previous research has demonstrated the effectiveness of various types of contact between coach and client in improving behavioral health outcomes [27,76,77]. During the weekly contacts, the coach encouraged the participants to adopt and maintain PA behavior by supporting their basic psychological needs at the personal level (PI), by providing social identity-based normative support for PA (SI) or by applying both counseling strategies (JI).

In addition to the informative session on ageing and PA at the beginning of the six-week intervention and the following weekly contacts with the coach, participants received a structured walking program during the intake. The walking program consisted of weekly schedules of uninterrupted walks (described in terms of minutes) with gradually increasing volume and intensity on most days of the week. Participants were able to progress through the different levels of the walking program according to their individual abilities and preferences. Consistent with SDT and in particular to facilitate the need for autonomy, participants of PI and JI were also explained a similar cycling and swimming program and received a booklet with home-based exercises to improve their strength, flexibility and balance. By presenting different PA opportunities, they were encouraged to engage in a PA that fitted their lifestyle, abilities and interests.

Intervention conditions

Personal identity condition

Participants of PI received a six-week individually-tailored PA counseling based on SDT. During the initial face-to-face contact (which lasted for approximately one hour), a HFS (MSc) encouraged each of the participants to formulate several personal PA goals by taking into account their PA history, preferences and abilities. Even though different PA programs were presented, the coach acted as a facilitator rather

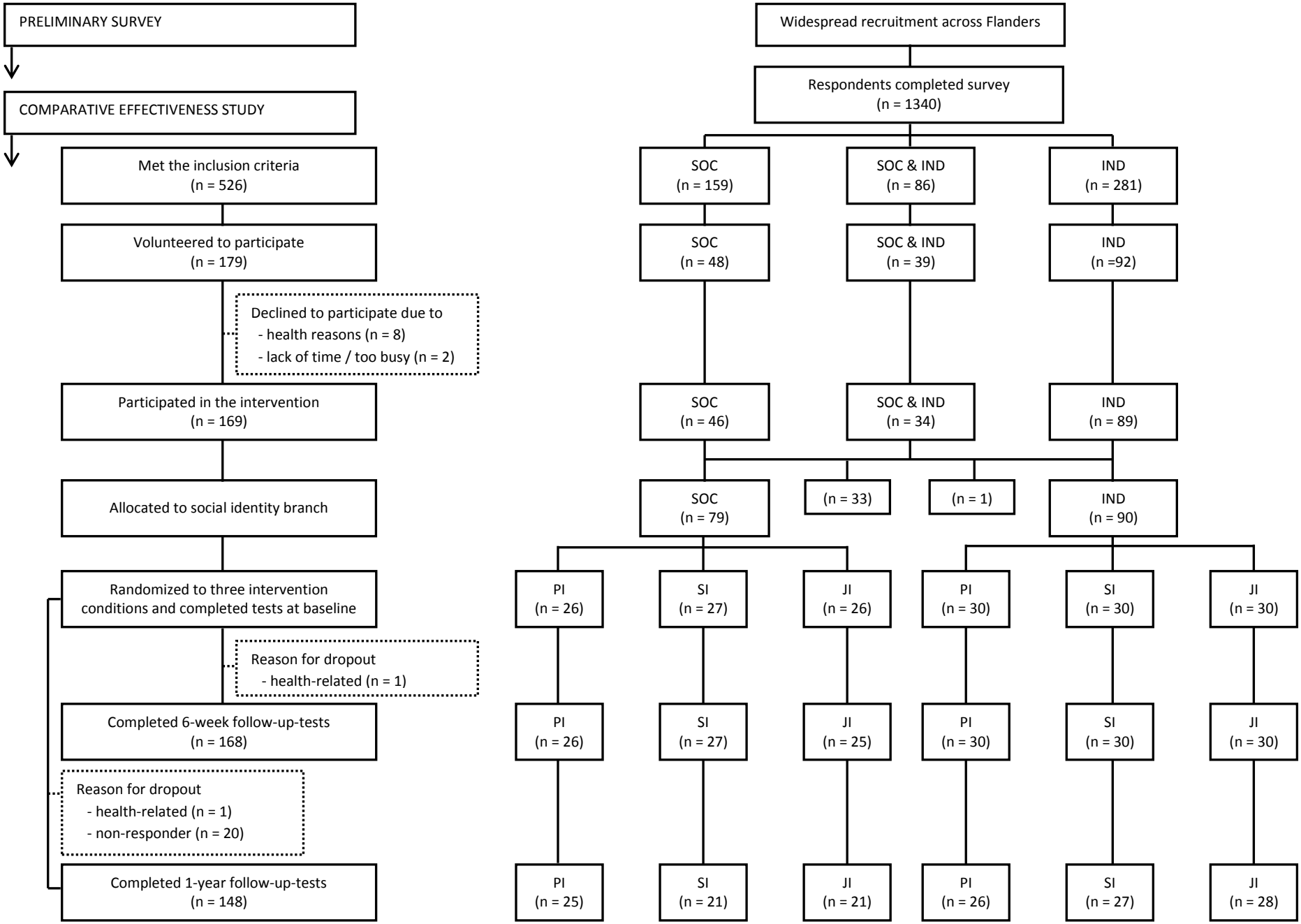

Figure 1 Flow chart of the study. *Note.* SOC, social identity of socially engaged persons; IND, social identity of independent persons; PI, personal identity condition; SI, social identity condition; JI, joined identity condition.

than a prescriber of PA. More specifically, participants were stimulated to decide themselves which PA type and intensity they were planning to perform, whether or not by making use of the provided walking, cycling, swimming or home-based schedules.

At each contact during the counseling period, the coach explicitly fostered the three psychological needs outlined by SDT, i.e. the need for autonomy, the need for competence and the need for relatedness

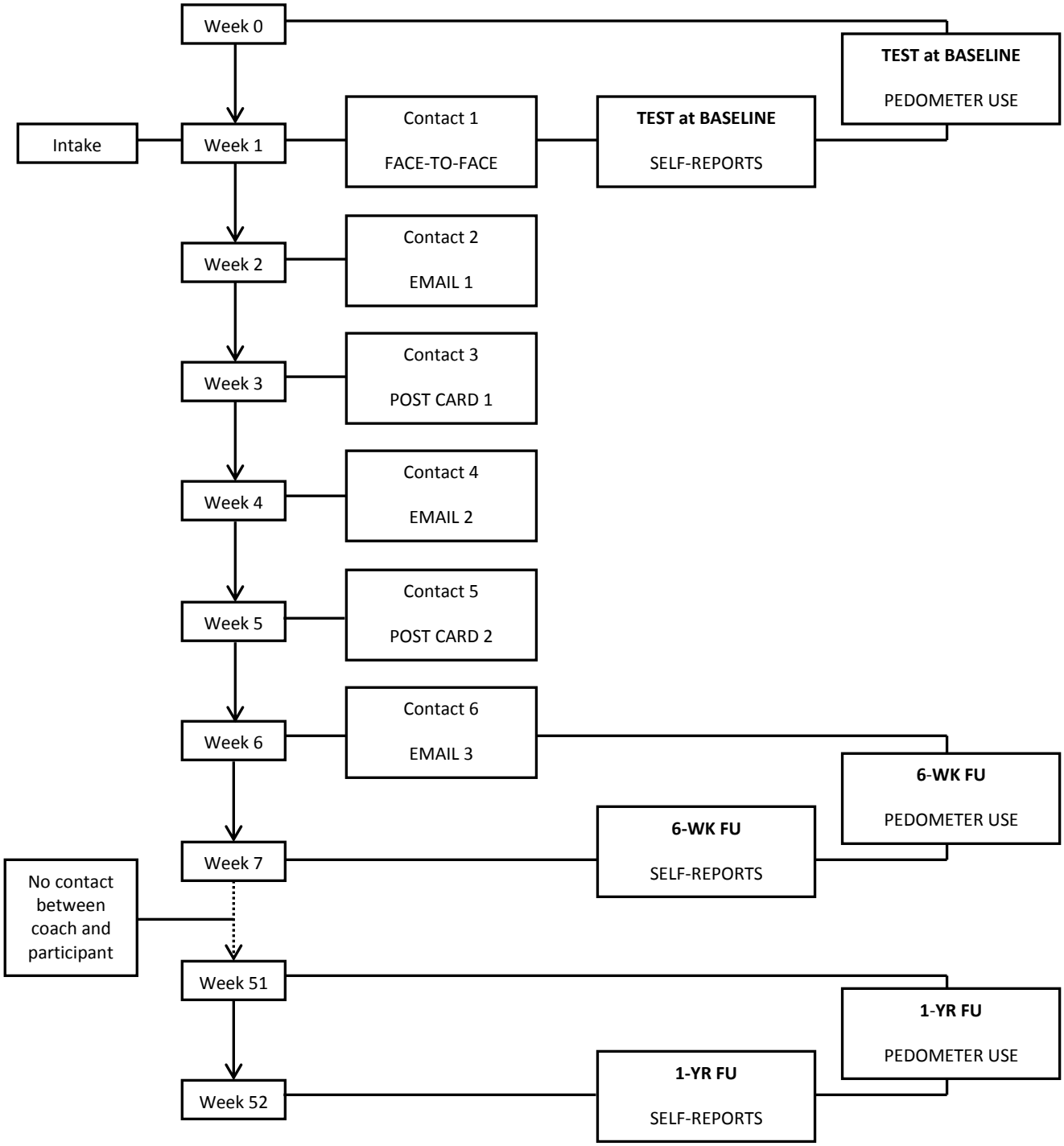

Figure 2 Build-up of the intervention procedure. *Note.* 6-WK FU, six-week follow-up; 1-YR FU, one-year

at the personal level. In particular, the coach supported participants' need for *autonomy* by minimizing pressure, by using autonomy-supportive language (e.g., pronouncing 'may' instead of 'must'), by providing informational feedback and a meaningful rationale for given advice, by acknowledging participants' perspective and by using client-centered strategies such as exploring options. Moreover, by encouraging the participants to initiate actions for their own personally valued reasons (e.g., engaging in PA because of the health-related benefits), the coach facilitated participants' *identified form of motivational regulation*.

The coach supported participants' need for *competence* by formulating positive feedback and verbally praising the participants for their effort and progress, by providing structure, by asking for clarification, by helping the participants to develop clear expectations and to set up realistic but challenging goals, by communicating clear instructions (e.g., with respect to participants' personal PA plan) and by reinforcing self-motivational statements.

Finally, the coach supported participants' need to *feel (interpersonally) related* by demonstrating understanding, by showing unconditional regard, by using non-judgmental language, by expressing enthusiasm and by creating an individualized, empathetic, warm and positive atmosphere (e.g., by active listening).

In addition to the need-supportive counseling, the PA coach applied three behavior change techniques to stimulate the participants to adopt and maintain PA: (1) planning, i.e. stimulating the participants to specify their PA goals not only by type and intensity but also by time frame and location, and helping them to plan the proposed PA in their weekly schedule; (2) barrier identification, i.e. encouraging the participants to identify barriers and to make up a strategy to overcome them; and (3) suggesting prompts and cues, i.e. teaching the participants to recognize environmental cues that can be used as a reminder to perform the proposed PA [78].

During the individually-tailored and need-supportive PA counseling in PI, the coach explicitly underscored participants' personal characteristics and their uniqueness. In particular, the PA coach made participants' personal identity salient (compared to other individuals' personal identities) rather than focusing on their categorization as members of a social group such as SOC / IND. In this respect, PI can be considered as a personally-oriented counseling procedure. The following statements and types of images give a notion of the PA counseling applied in PI: 'Keep up the good work!', 'Exercising the way you are / want', 'Well done, Rudi!', 'Making your own choice', 'Every step counts', 'Rosette, how did your walk go? I hope you had a better feeling than last week', a visual logo depicting the importance to be physically active according to one's personal interests and abilities (Figure 3), a collection of images displaying older adults who perform different types of PA etc.

Social identity condition

Participants of SI received a six-week social identity-based PA counseling based on SCT. During the initial face-to-face contact (which lasted for approximately one hour), a HFS (MSc) pointed out individuals' innate tendency to evaluate and define themselves in terms of (salient) social categories [43,46]. In

particular, the coach specified the participants' group membership of SOC / IND, considering and referring to their strong identification with the particular social identity at the moment that they completed the survey. Furthermore, the beliefs, attitudes, norms, values and behaviors that fit the identity-based prototype were described explicitly. For example, the socially-oriented self-characteristic was underlined among participants who defined themselves in terms of a socially engaged person. By contrast, individuals' inherent pursuit to cope autonomously was emphasized among participants who identified themselves with IND. Considering the health promoting character of the intervention, the coach especially stressed PA behavior as highly normative for SOC and IND. For example, PA was put forward as a prototypical behavior for socially engaged (older) persons because it helps them to be able to persist in actively playing with their grandchildren, in participating in social activities organized by the community, in caring for other people etc. Moreover, PA was presented as an appropriate leisure-time activity for socially engaged persons because it is an easily accessible activity that can be performed in a (social) group. On the other hand, PA was put forward as a prototypical behavior for independent (older) persons because it helps them to be able to persist in living independently, in doing the things they want to do etc. Moreover, PA was presented as an appropriate leisure-time activity for independent persons because it can be performed individually and in a personal way. By categorizing the participants and by specifying group-based stereotypes, the HFS accentuated the similarities between the participants and other members of the social group.

Contrary to participants of PI and JI, participants of SI were not provided explicit need-support by the HFS. More specifically, the HFS did not give choice or personal control to the participants, and accordingly did not explicitly support their need for autonomy. In particular, participants were encouraged to engage in walking instead of being stimulated to engage in a PA type according to their preferences and abilities. Moreover, the HFS did not formulate positive feedback and did not praise participants' progress, and accordingly did not explicitly support their need for competence. In particular, participants were given non-personalized information on their identification with SOC / IND and on the association of the social identity with walking behavior instead of being helped to set up personal and realistic PA goals. Finally, the HFS did not individualize the contacts, and accordingly did not explicitly support participants' need for interpersonal relatedness. For example, the HFS did not use their name, did not refer to personal events etc.

At each contact during the counseling period, the coach encouraged the participants to engage in and maintain walking behavior by bringing the target identity into focus and by providing identity-based normative support for walking. Participants' *social identity (i.e. SOC or IND)* was made salient by endowing participants with a label at each contact in order to remind them of their membership of the social group. More specifically, at each contact, participants received the same visual logo depicting the meaningful association between walking behavior and SOC / IND, in different formats such as a sticker, a digital image or a post card (Figure 3). Even though contextual factors might have influenced participants' perceived salience of the social category, this weekly cue (re-) activated their cognitive categorization with SOC / IND.

At the follow-up contacts, the coach manipulated the *normative support for walking* through one of the following five strategies:

(1) Presenting *testimonies* of socially engaged / independent persons expressing their walking behavior as an integral part of their personality and lifestyle. For example, '... walking enables me to continue spending time with my grandchildren ... due to my walking activities I am able to stay in contact with other people, to care for them and to do things with them ... walking is consistent with other important things in my life ... my social life ...' (SOC); '... walking is essential for me to be fit, energetic and independent ... it helps me to stay strong and to be able to go out and do enjoyable thing rather than sitting in a chair all the time and having to rely on other people ... walking expresses who I am ...' (IND);

(2) Stating *(numerical) 'facts'* with respect to walking behavior among socially engaged / independent persons. For example, 'Research has indicated that most of the 55 to 70 year old persons who attach importance to social engagement and belongingness / independent living and going out participate in walking activities at a regular basis because they believe walking behavior is consistent with their values and beliefs';

(3) Creating a *visual logo* (Figure 3) that depicts the conceptual but meaningful association between walking behavior and social engagement / independence, i.e. a logo showing an image of persons holding hands with the catch phrase 'Walking for and together with each other' (SOC); or a logo showing an image of a person climbing stairs with the catch phrase 'Walking for independence' (IND);

(4) Illustrating *photographs* of individuals aged 55 to 70 years representing both stereotypical characteristics and normative behavior (i.e. walking) of SOC / IND, e.g. a person who is engaged in walking during volunteer work or who is accompanying his / her grandchild towards school on foot (SOC); a person who is rambling around in the village or who is gardening (IND);

(5) Formulating striking *slogans* that connect the particular identity and the subjective norms, e.g. 'Walking and being socially engaged are going hand in hand' (SOC); 'Walking and being independent are a strong pair' (IND).

Given that the coach explicitly focused on participants' categorization as members of a relevant social group rather than emphasizing their personal identity, the counseling procedure in SI can be considered as socially-oriented and non-personal. Moreover, by internalizing normative (walking) behavior as an aspect of participants' social self, the coach facilitated participants' *integrated form of motivational regulation*.

Joined identity condition

Participants of JI received a six-week individually-tailored and need-supportive as well as social identity-based PA counseling. Consistent with PI and SI, respectively, a HFS (MSc) targeted both

participants' personal and social self. In particular, the coach promoted PA behavior by supporting the three basic psychological needs as proposed by SDT and by postulating social identity-based normative support for PA according to SCT. Hence, various forms of autonomous regulation for PA were facilitated, i.e. identified regulation and integrated regulation. Given that SDT-based counseling involves the provision of choice and personal control, PA in general rather than walking was proposed as normative for SOC / IND. Even though the PA counseling in JI consisted of procedures applied in PI combined with procedures applied in SI, the number, format and duration of the manipulations were similar, i.e. one face-to-face session of approximately one hour, three email conversations and two post cards.

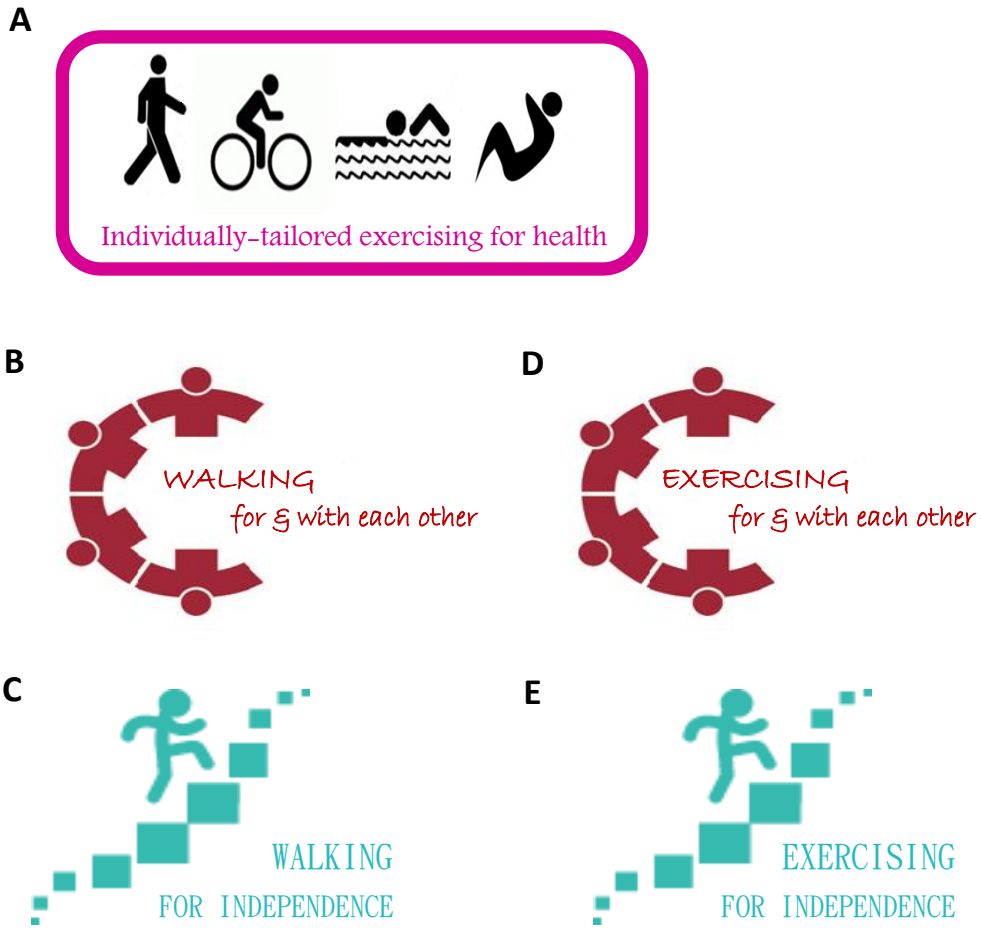

Figure 3 Visual logos. *Note.* Logo A depicts the importance to be physically active according to individuals' personal interests and abilities (referring to the personal identity condition); Logo B and logo C depict the conceptual association between walking behavior and the social identity of socially engaged and independent persons, respectively (referring to the social identity condition); Logo D and logo E depict the importance to be physically active according to individuals' personal interests as well as the conceptual association between physical activity behavior and the social identity of socially engaged and independent persons, respectively (referring to the joined identity condition).

Measurements

At baseline, participants were asked to report their *demographic characteristics* including age, gender, relationship status, educational level and status of retirement. Body mass index was estimated by means of participants' self-reported height and weight. *Criterion* and *predictor variables* of this health-oriented intervention were evaluated before (i.e. at baseline), immediately after (i.e. six-week follow-up; 6-WK FU) and one year after the beginning of (i.e. one-year follow-up; 1-YR FU) the six-week PA intervention, except for perceived need-support of the coach and perceived normative support for PA, which were only measured at 6-WK FU.

Criterion variables with respect to PA

Participants' PA level was measured by an objective and self-reported tool. The total number of *daily steps* was assessed with blinded Omron pedometers (Walking Style One). This pedometer type has been applied previously among older populations and has been shown to be reliable and valid [12,79-81]. Participants were asked to wear the pedometer during all waking hours, except for water-based activities, for seven consecutive days. The weighted mean of daily steps on weekdays and during the weekend was used for further analyses, i.e. ((5 x average number of steps on weekdays + 2 x average number of steps on weekend days) /7). Similarly, the weighted mean of *daily aerobic minutes* on weekdays and during the weekend was calculated, i.e. (5 x average number of aerobic minutes on weekdays + 2 x average number of aerobic minutes on weekend days) /7). Aerobic minutes refer to the period of time that an individual has been physically active at a continuous pace for at least ten minutes and at a minimum rate of 60 steps per minute.

Self-reported PA was measured by a modified version of the Godin Leisure-Time Exercise Questionnaire for which test-retest reliability and adequate validity have been demonstrated [82-84]. This brief and easy comprehensible questionnaire has been used previously in Western older populations [12,14,85]. Participants reported the number of times they engaged in mild, moderate and strenuous PA for at least 20 minutes in a typical seven-day period during the past month. The frequencies were weighted by the metabolic equivalents three, five and nine, respectively, and summed to obtain an overall score of self-reported PA.

Criterion variables with respect to health

Participants' subjective health and well-being were estimated by three different measures. Consistent with a PA promoting intervention of Pelssers et al. [12] among Flemish older adults, *self-rated health* was evaluated with a single item (i.e. How do you estimate your own health?) that was rated on a seven-point Likert scale ranging from '1 = I feel very unhealthy' to '7 = I feel very healthy'.

Physical well-being and *psychological well-being* were measured by the Leuven Well-Being Scale of Marcoen et al. [86]. Consistent with previous research among Flemish (older) adults and based on factor loadings and consistency scores [12,87-89], four items were selected out of the physical well-being subscale

and four items were selected out of the psychological well-being subscale. Physical well-being asks for individuals' physical health as well as for their happiness and acceptance of their body (e.g., 'I am satisfied with my body'). Psychological well-being refers to individuals' satisfaction with themselves and their lives (e.g., 'I am happy with the person I am). Participants indicated how frequently they felt as stated in each item on a seven-point Likert scale ranging from '1 = never' to '7 = always'. The scales proved to be internally consistent, with Cronbach's alpha coefficients of .83 for physical well-being and above .74 for psychological well-being at baseline, 6-WK FU and 1-YR FU.

Predictor variables

Consistent with the proposed hypotheses, the following two forms of autonomous motivation were measured: (1) *identified regulation*, referring to behavioral performance for its valued outcomes (e.g., 'I am engaged in PA because it is important to me to be physically active at a regular basis'); and (2) *integrated regulation*, indicating behavioral performance because of the assimilation with individuals' beliefs, values and aspirations (e.g., 'I am engaged in PA because it is an important part of who I am'). Identified regulation was assessed with three items of the Behavioural Regulation in Exercise Questionnaire-2 [90,91] and two items of the Exercise Motivation Scale [31,92,93]; Integrated regulation was assessed with six items of the Integrated Regulation Scale [94]. Participants responded to each item on a seven-point Likert scale ranging from '1 = not at all true for me' to '7 = very true for me'. Cronbach's alpha coefficients for identified regulation and integrated regulation at baseline, 6-WK FU and 1-YR FU exceeded respectively .84 and .94, indicating excellent internal consistency.

Perceived need-support of the coach was assessed with eleven items of the Basic Needs in Exercise Scale [95] and eight items of a modified version of the shortened Teacher As Social Context Questionnaire [96]. These validated questionnaires have been applied previously in research among Western populations [14,32,39,97-99]. The scale evaluated the three main dimensions of the coach's behavior as outlined by SDT, i.e. autonomy (seven items; e.g., 'My coach provided enough PA options to design goals that were in accordance with my lifestyle and interests'), competence (six items; e.g., 'My coach formulated positive feedback') and relatedness (six items; e.g., 'I could count on my coach when needed'). Participants indicated their agreement with the items on a seven-point Likert scale ranging from '1 = completely disagree' to '7 = completely agree'. As suggested by Vansteenkiste et al. [100], a general measure of perceived need-support, comprising the subscales of autonomy, competence and relatedness, was calculated. Very good internal consistency was shown with a Cronbach's alpha coefficient of .90.

Consistent with Pearson [68], *perceived normative support for PA* was assessed with two items: (1) 'To what extent did the intervention facilitate your belief that PA is a behavior that is supported by the reference group, i.e. SOC / IND?', and (2) 'To what extent did the intervention promote the idea that PA is typical for SOC / IND?'. Participants responded to each item on a seven-point Likert scale ranging from '1 = not at all' to '7 = very much'. The internal consistency was good with a Cronbach's alpha coefficient of .81.

A modified version of the Exercise Identity Scale [69,101] was used to evaluate participants' *degree of identification* with the PA identity on the one hand (three items) and the particular relevant social identity (SOC or IND) on the other hand (three items). Participants indicated to what extent they agreed with the given statements (e.g., 'PA / social engagement / independence is a central factor to my self-concept') on a seven-point Likert scale ranging from '1 = totally disagree' to '7 = totally agree'. Cronbach's alpha coefficients of .82 or more at baseline, 6-WK FU and 1-YR FU indicated good internal consistency for participants' degree of identification with the proposed identities.

The effectiveness of the social identity-based *manipulation* was measured with a single item, i.e. 'How frequently did the HFS emphasize your group membership of SOC / IND during the contacts of the six-week intervention period?'. Participants responded to the item on a seven-point Likert scale ranging from '1 = never' to '7 = always'.

Statistical analyses

Data analysis was performed using SPSS 19.0 (SPSS Inc., Chicago, IL, USA). Differences between PI, SI and JI were assessed with one-way ANOVAs and chi-square tests (χ^2) for continuous and categorical variables, respectively. Linear mixed models with an unstructured covariance structure were used to analyze between-condition differences in changes over time. Differences in changes over time between separate conditions were determined by contrast estimates. Mixed model analysis is a likelihood-based approach that models all observations with no attempt at imputation or adjustment for missing values, and is therefore considered as a reliable and statistically-grounded method for handling missing values in a longitudinal design [102]. Gender and educational level were entered as covariates in each model.

Indirect effects of perceived need-support and perceived normative support on PA through identified regulation and integrated regulation, respectively, were tested by the bootstrapping procedure of Preacher and Hayes [103]. Bias-corrected confidence intervals (95% CI) of the indirect effects were generated with 2000 resamples. Hierarchical pairwise regression analyses were conducted to examine the relation between participants' PA, perceived need-support and degree of identification with the PA identity and SOC / IND on the one hand and their health and well-being at 6-WK FU and 1-YR FU on the other hand.

Participants who exceeded three standard deviations from the PA mean score at baseline, 6-WK FU or 1-YR FU were considered as an outlier and hence excluded from all analyses (daily steps: n = 3; daily aerobic minutes: n = 4; self-reported PA: n = 5). The number of outliers was not significantly different between PI, SI and JI (daily steps: χ^2 = 2.048, p = .359; daily aerobic minutes: χ^2 = 3.631, p = .163; self-reported PA: χ^2 = 2.933, p = .231).

Because changes over time in PA and well-being were not significantly different between SOC and IND, the social identity branch was not included as a between-factor for data analyses (3 (time points) by 3 (conditions) by 2 (identity branches) interaction: daily steps: F = 1.876, p = .158; daily aerobic minutes: F = 0.380, p = .685; self-reported PA: F = 0.956, p = .387; self-rated health: F = 1.997, p = .140; physical well-being: F = 0.212, p = .809; psychological well-being: F = 0.647, p = .525). Significance level was set at $p < .05$.

Results related to demographics, dropout rates and performed manipulations

Demographic profile

The demographic characteristics of the sample at baseline are summarized in Table 1. In general, 39.1% of the participants were male and the mean age was 62.50 ± 4.84 years. The mean body mass index at baseline was 26.23 ± 3.59 kg/m², and respectively 49.1% and 14.8% of the participants were classified as overweight and obese. The average number of educational years was 13.98 ± 2.33, with almost two thirds of the participants (65.1%) having obtained a college or university degree. No significant differences emerged between PI, SI and JI with respect to the abovementioned variables, except for gender. In particular, a smaller men / women-ratio was found in PI compared with SI and JI (χ^2 = 6.400, p = .041).

Table 1 Demographic characteristics of the intervention conditions at baseline

	PI n = 56	SI n = 57	JI n = 56	*F* or χ^2	*p*
Age (average number of years ± SD)	63.46 ± 4.66	62.56 ± 4.84	61.46 ± 4.89	2.439	.090
Male (%)	26.8	40.4	50.0	6.400	.041
BMI (kg/m² ± SD)	26.61 ± 3.80	25.50 ± 3.15	26.58 ± 3.74	1.798	.169
Relationship status: having a partner (%)	71.4	79.0	85.7	3.412	.182
Educational level [a] (%)				4.225	.376
Primary	10.7	12.3	5.4		
Secondary	32.1	19.3	25.0		
High	57.1	68.4	69.6		
Status of retirement (%)	71.4	68.4	62.5	1.053	.591

Note. SD, standard deviation; PI, personal identity condition; SI, social identity condition; JI, joined identity condition; BMI, body mass index.

[a] A primary educational level refers to a minimum of nine years of education; A secondary educational level refers to a minimum of 12 years of education; A high educational level refers to 15 or more years of education.

Dropout

Dropout rates with respect to baseline and reasons for dropout are presented in Figure 1. Respectively 0.6% and 12.4% of the participants dropped out immediately after and one year after the six-week intervention, with no significant differences between PI, SI and JI (6-WK FU: χ^2 = 2.030, p = .362; 1-YR FU: χ^2 = 1.222, p = .543). The majority of the dropouts were non-responders. Dropouts were not significantly different from non-dropouts with respect to the demographics, body mass index and baseline levels of self-reported PA, self-rated health, subjective well-being and the predictor variables. However, daily steps and daily aerobic minutes at baseline were significantly higher in participants who attended the 1-YR FU compared with those who dropped out (daily steps: F = 8.136, p = .005; daily aerobic minutes: F = 4.012, p = .047).

Manipulation check

PI, SI and JI scored respectively 4.63 ± 1.51, 5.18 ± 1.05 and 5.04 ± 1.05 with respect to participants' perceived frequency that their group membership of SOC / IND was emphasized during the six-week intervention. SI and JI scored (significantly) higher than PI (F = 3.076, p = .049, PI < SI: p = .018, PI < JI: p = .079). This means that participants' group membership was successfully manipulated during the contacts in SI and JI.

Results and discussion related to PA

Results related to PA

Intervention effects

The effects of the three PA promoting strategies on pedometer-based and self-reported PA are presented in Table 2 and Figure 4. An overall change over (3) time was found across the conditions as well as within the separate conditions with respect to daily steps (overall: p < .001; PI: F = 8.933, p < .001, d = 0.44; SI: F = 25.978, p < .001, d = 0.76; JI: F = 17.769, p < .001, d = 0.64), daily aerobic minutes (overall: p < .001; PI: F = 3.293, p = .045, d = 0.26; SI: F = 17.934, p < .001, d = 0.68; JI: F = 10.833, p < .001, d = 0.39) and self-reported PA (overall: p < .001; PI: F = 7.651, p = .001, d = 0.66; SI: F = 5.481, p = .007, d = 0.43; JI: F = 8.541, p = .001, d = 0.53) (Table 2). In particular and consistent with *H1a*, significant increases in daily steps, daily aerobic minutes and self-reported PA emerged in each of the intervention conditions from baseline to 6-WK FU (all p < .001) and from baseline to 1-YR FU (all p < .001). This finding demonstrates that the three PA promoting strategies, either personally-oriented or socially-oriented, were effective in increasing participants' PA level, both in the short and in the long term.

Contrary to *H1b* and *H1c*, overall changes in daily steps, daily aerobic minutes and self-reported PA were not significantly different between the intervention conditions (steps: p = .472; aerobic minutes: p = .208; self-reported PA: p = .125) (Table 2). This means that all three PA promoting strategies were equally effective in promoting PA behavior. Similarly, with respect to changes in PA between PI, SI and JI separately, contrast estimates showed no significant differences from baseline to 6-WK FU and from baseline to 1-YR FU, except for aerobic minutes. More specifically, SI increased significantly more in aerobic minutes from baseline to 6-WK FU compared with PI (t = 2.108, p = .037).

PA health recommendations

In order to understand the PA increases from a health promoting perspective, the intervention effects on PA were evaluated in terms of the recommended PA level for health. In particular, PA levels needed to obtain health benefits were evaluated. Consistent with the step-based recommendations for adults [104], respectively 0.0%, 21.9% and 15.4% of the participants obtained the threshold of 10 000 steps each day at baseline, at 6-WK FU and at 1-YR FU. Consistent with the step-based recommendations for

adults aged 65 years or more [105], respectively 6.8%, 67.1% and 67.7% of the participants attained an average of at least 7000 steps each day at baseline, at 6-WK FU and at 1-YR FU. Respectively more than 90.0% and more than 82.0% of the participants increased in step-based PA and self-reported PA, both from baseline to 6-WK FU and from baseline to 1-YR FU. Participants who increased their PA level had significantly lower baseline scores of PA compared with those who did not increase in PA. For example, participants who increased their daily steps from baseline to 1-YR FU attained on average 5002.99 steps at baseline whereas participants who did not increase their daily steps during this time period had an average of 6345.03 steps at baseline (F = 4.473, p = .036). No differences were found between the three interventions conditions with respect to the abovementioned analyses.

Table 2 Estimated means (SE) for PA by time and condition

	PI	**SI**	**JI**	**one-way ANOVA**	**3 x 3 interaction effect**		**time effect**	
	mean (SE)	mean (SE)	mean (SE)	*F*	*F*	Cohen's *d*	*F*	Cohen's *d*
Daily steps								
Baseline	4757.12 (209.33)	4908.22 (196.65)	4788.41 (202.48)	0.235				
6-WK FU	8327.89 (327.12)	8250.78 (319.35)	8188.80 (332.56)	0.061	0.889	0.26	48.250***	0.88
1-YR FU	7717.57 (303.37)	7647.37 (301.17)	8068.05 (305.87)	0.068				
Daily aerobic minutes								
Baseline	5.99 (0.80)	5.34 (0.71)	4.45 (0.74)	0.407				
6-WK FU	24.13 (2.30)	24.18 (2.22)	19.36 (2.36)	0.931	1.490	0.29	26.044***	0.65
1-YR FU	20.51 (2.43)	24.87 (2.38)	22.51 (2.46)	1.118				
Self-reported PA (GLTE)								
Baseline	19.72 (1.65)	19.48 (1.53)	18.25 (1.61)	0.090				
6-WK FU	33.64 (2.79)	33.82 (2.66)	33.71 (2.80)	0.121	1.835	0.22	18.005***	0.69
1-YR FU	33.09 (2.34)	27.97 (2.29)	29.30 (2.35)	0.672				

Note. SE, standard error; PA, physical activity; PI, personal identity condition; SI, social identity condition; JI, joined identity condition; 6-WK FU, six-week follow-up; 1-YR FU, one-year follow-up; 3 x 3 interaction effect, interaction effect over (3) time and between (3) conditions; time effect, overall (3) time effect over the conditions; GLTE, score on Godin Leisure-Time Exercise Questionnaire.

*, p < .05; **, p < .01; ***, p < .001

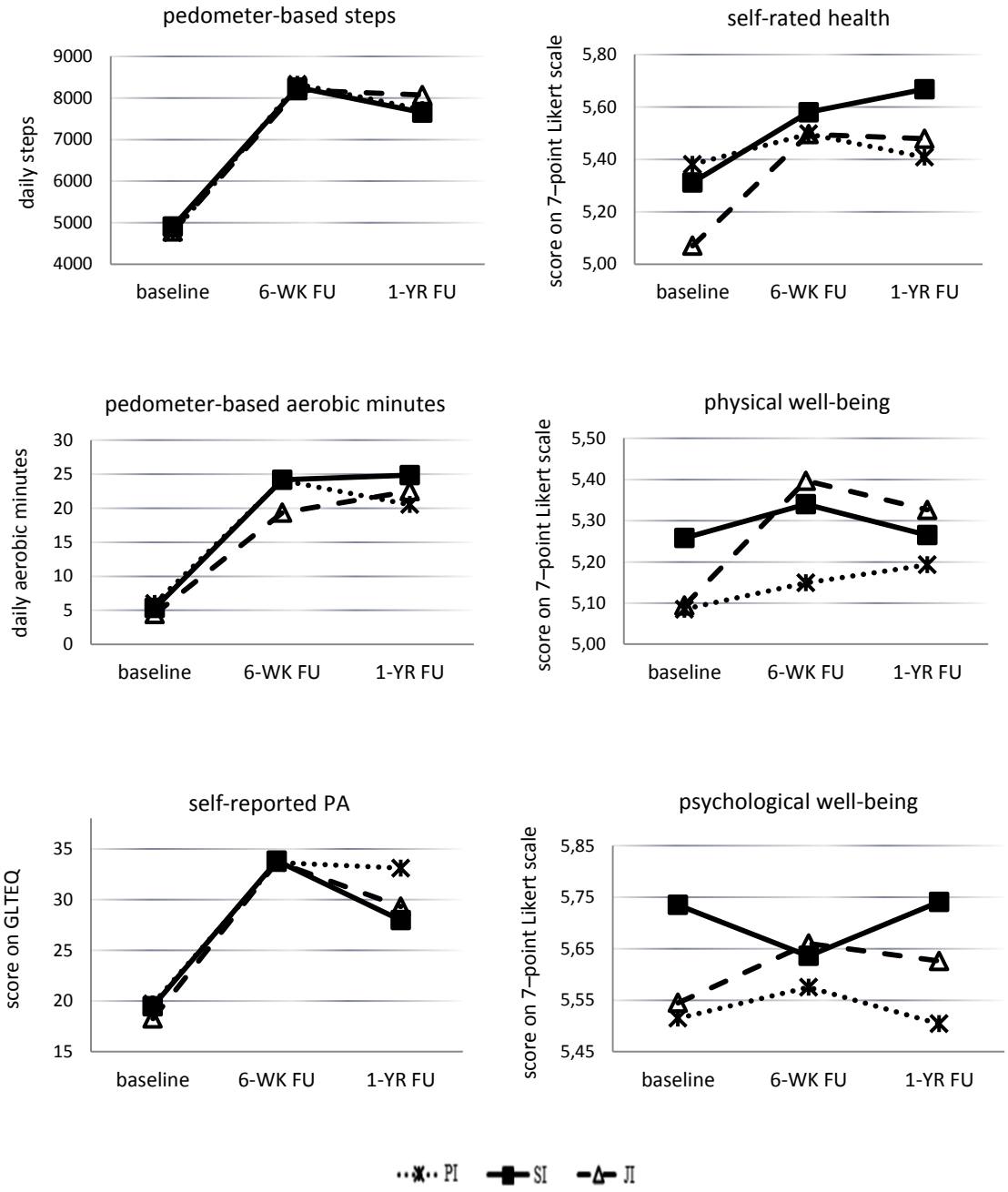

Figure 4 Intervention effects on physical activity and subjective health. *Note.* PA, physical activity; GLTEQ, Godin Leisure-Time Exercise Questionnaire; 6-WK FU; six-week follow-up; 1-YR FU, one-year follow-up; PI, personal identity condition; SI, social identity condition; JI, joined identity condition.

Mediating role of identified regulation on the relation between perceived need-support and PA

Perceived need-support of the coach after the intervention was 6.15 ± 0.52, 6.15 ± 0.56 and 6.14 ± 0.61 in PI, SI and JI, respectively, with no significant differences between the conditions (F = 0.011, p = .990). Scores of identified regulation at baseline, at 6-WK FU and at 1-YR FU were 5.96 ± 0.82, 6.15 ± 0.70 and 6.08 ± 0.77, respectively, with no significant differences between the conditions (baseline: F = 0.652, p = .522; 6-WK FU: F = 0.605, p = .547; 1-YR FU: F = 0.291, p = .748). Identified regulation significantly increased from baseline to 6-WK FU (p = .001, d = 0.24) but not from baseline to 1-YR FU (p = .207, d = 0.09). Overall changes over (3) time in identified regulation were not significantly different between the intervention conditions (F = 0.627, p = .644, d = 0.10). Similarly, contrast estimates showed no significant differences in changes in identified regulation between PI, SI and JI separately.

Bootstrapping analyses (Table 3) demonstrated a significant relation between perceived need-support at 6-WK FU and identified regulation at 6-WK FU and at 1-YR FU (α-paths). This means that, irrespective of type of intervention, the higher the perceived need-support after the intervention, the higher participants' identified regulation to engage in PA, even one year after the intervention. Moreover, significant ß-paths indicated that higher levels of identified regulation were associated with higher levels of (pedometer-based) PA. As proposed by SDT and consistent with *H2a*, identified regulation significantly contributed to the indirect effects of perceived need-support at 6-WK FU on (pedometer-based) PA at 6-WK FU and at 1-YR FU (αß-path).

Table 3 Mediation effect of identified regulation on PA at 6-WK FU and 1-YR FU

	α-path	**β-path**	**αβ-path**				**total model**	
	coefficient (SE)	coefficient (SE)	coefficient (SE)	95% CI of αβ			R^2	F
6-WK FU								
Daily steps	0.413 (0.056)***	325.278 (143.251)*	134.406 (59.354)	30.462	to	262.360	0.277	58.112***
Daily aerobic min.	0.388 (0.057)***	2.636 (1.116)*	1.024 (0.457)	0.194	to	2.001	0.130	22.562***
Self-reported PA	0.402 (0.051)***	0.523 (1.398)	0.211 (0.608)	- 1.036	to	1.396	0.145	27.456***
1-YR FU								
Daily steps	0.493 (0.069)***	433.318 (136.805)**	213.517 (84.811)	64.755	to	401.182	0.192	30.172***
Daily aerobic min.	0.498 (0.070)***	2.306 (1.137)*	1.148 (0.568)	0.078	to	2.338	0.153	22.720***
Self-reported PA	0.483 (0.067)***	1.849 (1.016)	0.892 (0.517)	- 0.113	to	1.929	0.247	46.067***

Note. PA, physical activity; 6-WK FU, six-week follow-up; 1-YR FU, one-year follow-up; Daily aerobic min., daily aerobic minutes; Self-reported PA, self-reported physical activity measured by the Godin Leisure-Time Exercise Questionnaire; α, estimate of the direct effect of perceived need-support at 6-WK FU on the proposed mediator, i.e. identified regulation; β, estimate of the direct effect of the proposed mediator (i.e. identified regulation) on PA while controlling for the effect of perceived need-support; αβ, estimate of the indirect effect of perceived need-support on PA through the proposed mediator, i.e. identified regulation; SE, standard error; 95% CI, 95% bias corrected confidence interval with the empirically derived bootstrapped sampling distribution of αβ (result of 2000 bootstrap resamples). Baseline PA was included as additional covariate.

*, p < .05; **, p < .01, ***, p < .001

Mediating role of integrated regulation on the relation between perceived normative support and PA

Perceived normative support for PA after the intervention was 5.78 ± 1.28, 5.84 ± 1.04 and 5.80 ± 0.97 in PI, SI and JI, respectively, with no significant differences between the intervention conditions (F = 0.051, p = .950). Scores of integrated regulation at baseline, at 6-WK FU and at 1-YR FU were 4.91 ± 1.37, 5.21 ± 1.23 and 5.07 ± 1.34, with no significant differences between the conditions (baseline: F = 0.199, p = .820; 6-WK FU: F = 2.177, p = .117; 1-YR FU: F = 1.832, p = .164). Integrated regulation significantly increased from baseline to 6-WK FU (p < .001, d = 0.22) but not from baseline to 1-YR FU (p = .091, d = 0.09). Overall changes over (3) time in integrated regulation were not significantly different between the intervention conditions (F = 1.674, p = .159, d = 0.27). Similarly, contrast estimates showed no significant differences in changes in integrated regulation between PI, SI and JI separately.

A significant relation between perceived normative support for PA at 6-WK FU and integrated regulation at 6-WK FU was found (α-paths) (Table 4). As proposed by SCT and consistent with *H2b*, participants' integrated regulation at 6-WK FU was positively associated with (pedometer-based) PA at 6-WK FU (ß-paths), and integrated regulation at 6-WK FU significantly contributed to the indirect effect of perceived normative support on (pedometer-based) PA at 6-WK FU (αß-path). At 1-YR FU, a significant contribution of integrated regulation to the indirect effect of perceived normative support on PA was found with respect to self-reported PA but not with respect to pedometer-based PA.

Table 4 Mediation effect of integrated regulation on PA at 6-WK FU and 1-YR FU

	α-path	**β-path**	**αβ-path**				**total model**	
	coefficient (SE)	coefficient (SE)	coefficient (SE)	95% CI of αβ			R^2	F
6-WK FU								
Daily steps	0.303 (0.051)***	167.655 (79.282)*	50.791 (25.628)	7.563	to	109.301	0.276	57.933***
Daily aerobic min.	0.299 (0.052)***	1.247 (0.618)*	0.373 (0.215)	0.008	to	0.869	0.129	22.366***
Self-reported PA	0.296 (0.047)***	- 0.035 (0.767)	- 0.010 (0.245)	- 0.483	to	0.493	0.150	28.482***
1-YR FU								
Daily steps	0.086 (0.066)	220.898 (73.430)**	19.077 (16.930)	- 7.884	to	62.632	0.188	29.335***
Daily aerobic min.	0.075 (0.067)	0.890 (0.606)	0.067 (0.081)	- 0.033	to	0.338	0.144	21.149***
Self-reported PA	0.142 (0.061)*	1.334 (0.551)*	0.189 (0.127)	0.010	to	0.550	0.251	47.151***

Note. PA, physical activity; 6-WK FU, six-week follow-up; 1-YR FU, one-year follow-up; Daily aerobic min., daily aerobic minutes; Self-reported PA, self-reported physical activity measured by the Godin Leisure-Time Exercise Questionnaire; α, estimate of the direct effect of perceived normative support at 6-WK FU on the proposed mediator, i.e. integrated regulation; β, estimate of the direct effect of the proposed mediator (i.e. integrated regulation) on PA while controlling for the effect of perceived normative support; αβ, estimate of the indirect effect of perceived normative support on PA through the proposed mediator, i.e. integrated regulation; SE, standard error; 95% CI, 95% bias corrected confidence interval with the empirically derived bootstrapped sampling distribution of αβ (result of 2000 bootstrap resamples). Baseline PA was included as additional covariate.

*, p < .05; **, p < .01, ***, p < .001

Discussion related to PA

PA increases

As stated in *H1a*, each of the intervention conditions yielded significant and substantial increases in PA, in the short and the long term. The PA increases in PI (and JI) are in line with previous SDT-grounded research showing a positive influence of individually-tailored need-supportive counseling on individuals' PA behavior [14,18,20,27,36]. In this respect, supporting older adults' need for autonomy (e.g., by acknowledging their perspective and exploring options), their need for competence (e.g., by providing positive feedback and helping them to set up a structured and personal PA plan) and their need for relatedness at the personal level of the self (e.g., by showing unconditional regard and demonstrating understanding) appears to be a fruitful strategy to improve their PA behavior.

The findings with respect to PA behavior in SI (and JI) are consistent with previous research on social identification in which positive associations between identity-based norms towards PA and PA attitudes, intentions and behaviors were demonstrated [57,59,61]. Moreover, the results of this study indicated substantial PA increases in PI and JI immediately after and one year after the socially-oriented PA counseling. Therefore, and in particular because of the following three reasons, the present study extends previous research: (1) This study demonstrated the year-round effectiveness of a *longitudinal intervention* in which identity-based normative support for PA was postulated rather than presenting only cross-sectional associations or short-term effects of individuals' identification on their PA behavior [50,62]; (2) This study provided evidence for the effectiveness of norm-based PA counseling that was *explicitly grounded in SCT*. By contrast, most of the previous studies have tested the validity of the Theory of Planned Behavior [106] by incorporating PA identity as an additional determinant of PA intentions and behaviors [59,60,107]; and (3) This study showed the positive influence on PA behavior of proposing *PA as a prototypical behavior of a relevant social identity* (i.e. SOC or IND; e.g., 'I am physically active because I believe I am a socially engaged / an independent person') rather than indicating the (predictive) relationship between individuals' PA identity itself and their PA behavior (i.e. 'I believe I am a physically active person') [62]. In this respect, mixed model analyses did not reveal significantly different changes over time in PA and well-being between the two identity branches, i.e. SOC and IND. This points out the potential to generalize identity-based PA promotion to a variety of social identities, as long as they are relevant to the particular population group.

Overall, the findings of this study suggest that targeting different levels of the self can be successful in adopting and maintaining PA among older adults not attaining the physical activity recommendations for health but motivated to enhance their health and to increase their PA, and especially among those with initially lower levels of PA. The maintenance of the increased PA levels after a period of one year is especially remarkable considering the limited evidence for long-term effects of PA promoting strategies [13]. Moreover, it is noteworthy that the effect sizes observed in the present study are large (i.e. > .64 across the conditions) compared to the effect sizes reported in other effective psychological interventions

(i.e. .20 to .40) [108,109]. Similarly, the demonstrated increases in daily steps (i.e. 3438 steps/day from baseline to 6-WK FU and 2993 steps/day from baseline to 1-YR FU) are large compared with the average PA increases reported in pedometer-based literature (i.e. 2000-2500 steps/day and 775 steps/day in younger and older adult populations, respectively) [105,110]. Even though participation and measurement effects might have contributed to the PA increases, the maintenance of the increased PA levels suggests the occurrence of a considerable intervention effect as well.

In line with previous research [11,16], the underlying theoretical framework of SDT or / and SCT in each of the interventions may have played an important role in the attainment of large and sustained intervention effects on participants' behavioral change. Moreover, the counseling procedures entailed either the designing of individualized PA goals or the provision of structured PA schemes. Therefore, the PA increases in each of the conditions are not only consistent with SDT or / and SCT but also with the Goal-setting Theory of Locke and Latham [111], which underscores the importance of formulating concrete and realistic goals to change individuals' behavior. In accordance with the PA increases at the group level, subsequent analyses revealed a substantial effect at the individual level. More specifically, a considerable larger proportion of participants attained the PA health recommendation at follow-up compared with baseline. The findings with respect to PA highlight the potential of both personally-oriented and socially-oriented PA promoting strategies to change older adults' lifestyle from sedentary, inactive or insufficiently active to regularly active.

Performed PA types

Comparable results were found with respect to daily steps, daily aerobic minutes and self-reported PA, even though these three measurement tools assess different dimensions of PA behavior. More specifically, daily steps reflect each of individuals' activities that generate steps during a 24-hour period of time, irrespective of the PA intensity (e.g., mild, moderate, strenuous), duration (e.g., three minutes, three hours), type (e.g., climbing stairs, dancing, walking, cycling) and purpose (e.g., walking around at home, active transportation, shopping, going for a planned one-hour walk). On the other hand, pedometer-based aerobic minutes and self-reported PA measured by the Godin Leisure-Time Exercise Questionnaire only refer to activities that last for a longer and uninterrupted period of time, i.e. at least ten minutes and at least 20 minutes, respectively. Consequently, they are more likely to involve planned, purposeful and leisure-time PA such as following a dancing class or going for a walk in the forest. The similar increases in steps, aerobic minutes and self-reported PA suggest that the PA counseling procedures have led the participants to increase both their (non-purposeful) general PA as well as their (purposeful) leisure-time PA. More specifically, participants of PI and JI were encouraged to engage in PA according to their preferences, either purposeful or non-purposeful, e.g. by gardening, swimming, active playing with their grandchildren, active transportation, doing home-based exercises etc. On the other hand, participants of SI were stimulated to walk during their daily activities as well as during their leisure time, e.g. by walking for transportation, using stairs, going for a walk etc.

Even though the different conditions yielded similar increases in most of the PA outcomes, SI increased significantly more in aerobic minutes from baseline to 6-WK FU compared with PI. This is consistent with the variance in recommended PA types in PI, SI and JI. In particular, participants of SI were especially stimulated to engage in walking activities, in order to avoid supporting their personal need for autonomy by giving PA options. Nevertheless, subsequent analyses on participants' performed PA types indicated that not only participants of SI but also participants of PI and JI engaged in walking activities. More specifically, respectively 81.7%, 85.7% and 87.2% of the participants reported that they had participated in walking (≥ ten minutes) at least once during the week before measurements at baseline, at 6-WK FU and at 1-YR FU, with no significant differences between the conditions (baseline: χ^2 = 2.556, p = .279, 6-WK FU: χ^2 = 2.731, p = .255; 1-YR FU: χ^2 = 0.637, p = .727). This can be explained by the easy accessibility of this type of PA. Moreover, walking has been reported as the preferred PA type among older adults, and accordingly accounts for much of their PA [4,17,81].

Between-condition differences

Contrary to *H1b*, changes in PA were not significantly different between PI and SI, except for the aerobic minutes from baseline to 6-WK FU. The lack of between-condition differences is in contrast with the assumptions of the Social Identity Approach. More specifically, this theory postulates that the way in which individuals categorize themselves and the (level of) identity that is activated might influence their behavior and cognitions differently [47,50]. Moreover, our results differ from those reported by Pearson [68] who found that norm-based PA promotion among spiritually caring and independent adult women is more successful in the maintenance of their PA than PA promotion that focuses on the women's personal identity. It remains an open question whether or not these different findings are caused by the different underlying theoretical frameworks of the PA interventions (i.e., SDT and SCT vs. Theory of Planned Behavior) or by the different characteristics of the participants' samples (i.e., men and women aged 55 to 70 years vs. women aged 25 to 40 years) in the respective studies. Moreover, even though it appears that similar identities were used in both studies (i.e., socially engaged and independent persons vs. spiritual caring and independent persons), the meaning or connotation associated with the identities might have been different. The similar short- and long-term PA patterns in PI and SI presented in this study indicate that targeting the personal self and targeting the social self can be equally effective in promoting PA among insufficiently active older adults. This finding suggests that a PA counselor can either emphasize clients' unique characteristics, support their personal needs and create a warm interpersonal relationship or emphasize clients' membership of a behaviorally relevant reference group and propose group-based normative support for (a specific type of) PA.

Contrary to *H1c*, emphasizing both personal and group-based characteristics did not yield larger PA increases in JI compared with PI and SI. Nevertheless, SIT and SCT assume that, during their daily life, individuals identify themselves with their personal identity or with a particular social identity (i.e. group), depending on which identity they perceive as most relevant, important and meaningful in the particular

context [43,45,46,48]. In the present study, PA was related to participants' personal self as well as to their social self among participants of JI whereas PA was related to only one level of their self among participants of PI (personal self) and participants of SI (social self). Therefore, it was expected that participants of JI would be likely to engage in PA in a larger number of contexts during their daily life than participants of PI and SI. In particular, participants of PI were expected to engage in PA only in contexts in which they would categorize themselves as a unique person, participants of SI were expected to engage in PA only in contexts in which they would categorize themselves as a member of SOC / IND, and participants of JI were expected to engage in PA in contexts in which they would categorize themselves as a unique person as well as in contexts in which they would categorize themselves as a member of SOC / IND. However, consistent with the abovementioned contextuality of identification, it might be that participants were able to categorize themselves at only one level of the self during the contacts as well. In this respect, participants of JI probably engaged in PA when they identified themselves either with their personal identity or with SOC / IND, depending on the identity with which they identified themselves during the previous contact moment.

Explaining PA increases

Consistent with the design of the counseling strategies in the intervention conditions, SI and JI scored (significantly) higher than PI with respect to participants' perceived frequency of their group membership of SOC / IND during the six-week intervention period. This result indicates that participants' group membership of SOC / IND was effectively made salient in SI and JI, and accordingly demonstrates a successful manipulation.

Nevertheless, as indicated above, targeting various levels of the self did not produce significantly different PA increases in PI, SI and JI. This finding can be related to the lack of significant differences between the conditions with respect to the psychological processes that were activated in order to promote participants' PA. More specifically, even though different psychological, sociological and behavioral determinants of PA were accentuated in PI, SI and JI, no significant differences emerged between the intervention conditions with respect to participants' perceived need-support, their perceived normative support for PA and their behavioral regulation after the intervention. The following four reflections provide a more detailed discussion with respect to the (unexpected) lack of differences in these behavioral processes:

(1) In general, the similar effects of the different counseling procedures on the abovementioned process measures, and accordingly on the PA outcomes, can (partially) be explained by the *participants' sample* [112]. More specifically, due to the voluntary character of study participation, the sample consisted of a rather homogenous group of relatively healthy community-dwelling adults aged 55 to 70 years who were motivated to enhance their health, and in particular to increase their PA;

(2) With respect to *participants' perceived need-support of the coach*, no significant differences were found between the intervention conditions. This is in contrast with our expectations,

given that the HFS explicitly supported the needs for autonomy, competence and interpersonal relatedness among participants of PI and JI whereas no explicit need-support was provided among participants of SI. The similar score on perceived need-support in all three conditions suggests that not only participants of PI and JI but also participants of SI experienced the (socially-oriented) counseling procedure as supportive for their personal needs. In this respect, and in line with previous research [12,14], feelings of *competence* might have been facilitated by the structure of the walking program. More specifically, by providing concrete and realistic weekly walking schemes with progressively increasing volume and intensity, participants were likely to experience success. Previous research has indicated that supporting only one psychological need postulated by SDT, which is in this case the need for competence, can be sufficient to produce positive effects on PA among older adults [38,40]. Moreover, a need-supportive intervention study in the school context suggested that perceiving or providing support for one of the psychological needs entails the support for the other needs as well [35,39]. More specifically, it was stated that, even though teachers explicitly distinguish between providing autonomy support, competence support and relatedness support, pupils do not make a distinction between the perceptions of the different needs but rather perceive need-support in general. In this respect, participants of SI might have perceived autonomy support and relatedness support as a result of the perceived competence support that was implicit to the structured walking program. The strong correlation between the three personal needs in each of the intervention conditions provides support for this reasoning (e.g., correlation between autonomy support and competence support: $r = .77$, $p < .001$).

In addition to the perceived competence support, which is assumed to be inherent to the walking program, participants of SI might have experienced the provided normative support for walking as supportive for their personal need for *autonomy*. More specifically, during the contacts, the HFS expressed a clear and meaningful rationale for PA (i.e. walking) engagement among members of SOC / IND, e.g. ‘given that walking can easily involve social contact, socially engaged persons consider this type of PA as an appropriate leisure-time activity‘. In this respect, social norms were provided in an informational rather than a suppressing way. Consequently, participants were likely to accept, agree and internalize group-based information because it was based on accurate and valid perceptions, attitudes and beliefs [49,50]. The provided identity-based normative support for PA in SI can thus be considered as closely related to the provided autonomy support in PI and JI. Moreover, as mentioned above, walking has been reported as a popular type of PA among older adults [17]. Therefore, participants may have perceived the proposed walking program as a personal choice, even though the HFS did not aim to support their need for autonomy.

Finally, each of the intervention conditions, and thus also SI, scored relatively high on *perceived relatedness* support at the personal level of the self, i.e. above 6.55 on a seven-point Likert scale with a minimum score of 4.50. This suggests that, despite the non-personalized contacts in SI, participants of SI evaluated the HFS as an understanding, empathetic and enthusiastic counselor. The highly perceived interpersonal relatedness support from the HFS can be inherent to the participants' sample. More specifically, considering that participants of the PA intervention were selected out of the pool of participants of the preliminary survey, they were probably appreciative and pleased to take part in the health-oriented scientific intervention. In this respect, the participants of SI might have experienced the contacts as supportive for their relatedness at the personal level of the self, even though the contacts in SI were not aimed to explicitly support this basic psychological need;

(3) With respect to *participants' perceived normative support for PA*, no significant differences were found between the conditions. This is in contrast with our expectations, given that the HFS postulated social identity-based PA norms among participants of SI and JI whereas no group-based influence was exerted among participants of PI. The similar score on perceived normative support for PA in all three conditions suggests that not only participants of SI and JI but also participants of PI found that the HFS proposed PA as a typical behavior for SOC / IND. The highly perceived normative support for PA among participants of PI can be explained by the (abovementioned) close association between autonomy support and perceived normative support for PA. More specifically, participants of PI were especially encouraged to initiate their actions (e.g., engage in PA) for their own personally valued reasons. In this respect, each of the participants might have inherently associated their (willingness to maintain their) social engagement / independence with (the need to be engaged in) PA, especially because all participants identified themselves strongly with SOC / IND, including those in PI (PI: 6.22 ± 0.65; SI: 6.05 ± 0.68; JI: 6.16 ± 0.74; $F = 0.850$, $p = .429$). Therefore, participants of PI might have been motivated to engage in regular PA to keep their good health, and in this way be able to maintain their group membership of SOC / IND. By emphasizing the importance of the personally valued outcomes of PA during each contact, the HFS might thus have provided normative support for PA among participants of PI;

(4) With respect to *participants' behavioral regulations* after the intervention, no significant differences were found between the conditions. As a result, both the quality and the quantity of motivation were similar in PI, SI and JI. This finding is in contrast with our expectations, given that the HFS explicitly encouraged participants of PI to perform PA because of its personal meaningfulness, and accordingly aimed to facilitate their identified regulation. By contrast, the HFS explicitly encouraged participants of SI to perform PA because of its association with their membership of SOC / IND, and accordingly aimed to facilitate their integrated regulation. The similar changes in identified and integrated regulation in PI, SI and JI

indicate that both the need-supportive PA counseling and the norm-based PA counseling encouraged the participants to perform PA because of its personally important outcomes as well as because of its congruence with other needs and values in their life. This might be explained by the following three aspects: (1) Even though identified and integrated regulation entail some theoretically-grounded variance with respect to individuals' behavioral motives, it is difficult to empirically distinguish between those self-determined forms of regulation [18]; (2) Identified regulation and integrated regulation have been shown to strongly correlate with each other and to operate simultaneously. More specifically, individuals who value the benefits associated with regular PA are considered to be likely to incorporate that behavior into their sense of identity [20,29]. The results of this study provide evidence for the strong correlation between these two types of self-determined behavioral regulation (e.g., correlation between identified and integrated regulation at baseline: $r = .67$, $p < .001$); and (3) Previous literature on need-supportive PA counseling has indicated that supporting individuals' psychological needs positively affects each form of self-determined behavioral regulation, including both identified and integrated regulation [30,101,108].

Irrespective of the reported changes in motivation, participants scored relatively high on self-determined behavioral regulation at baseline, i.e. above 5.95 and 4.90 on a seven-point Likert scale with respect to identified regulation and integrated regulation, respectively. This indicates that participants were initially already autonomously motivated to engage in PA, both because of the personal importance of the PA outcomes and because this behavior fits their personality. Considering the high baseline scores on identified and integrated regulation, the increases in those self-determined types of motivation from baseline to 6-WK FU even strengthen the effectiveness of the manipulations in improving individuals' autonomous motivation.

Given that neither the PA outcomes nor the underlying psychological processes were significantly different between PI, SI and JI, mediational influences of behavioral regulations on participants' PA behavior were evaluated across the intervention conditions. In this respect, and as stated in *H2a*, higher levels of participants' perceived need-support of the coach yielded higher levels of (pedometer-based) PA through higher levels of identified regulation. The mediating role of self-determined behavioral regulation on the relation between need-support and PA is consistent with the tenets of SDT [21] as well as with previous literature on need-supportive PA promotion [14,20,27,32]. This mediating influence was not only found immediately after but also one year after the intervention. This is noteworthy and indicates that participants' perceived need-support immediately after a PA intervention may influence their degree of identified regulation and their PA behavior in the long term.

Furthermore, the findings of the present study partially supported *H2b*. More specifically, and in accordance with SCT, higher levels of perceived normative support for PA were associated with higher levels of pedometer-based PA through higher levels of integrated regulation, but only immediately after the

intervention. A similar mediational influence could be observed with respect to self-reported PA, but only one year after the intervention. These results are consistent with previous research on individuals' motivational profile towards PA [29,30], in which integrated regulation was found to positively predict regular PA, and in particular its frequency and duration. Accordingly, and as stated by Dacey [15], this result indicates that viewing PA as a part of one's identity can strongly contribute to his / her PA behavior, especially during the late adulthood.

The observed mediational processes influencing PA point at the importance of encouraging policy makers to support the implementation of PA programs in which coaches facilitate highly qualitative forms of behavioral regulation, either by highlighting the importance of personally meaningful outcomes of PA (i.e. identified regulation) or by helping older adults to believe that PA fits their personality (i.e. integrated regulation).

However, it should be noted that mediation effects on pedometer-based PA and on self-reported PA were inconsistent. More specifically, SDT-grounded mediations and SCT-grounded mediations at 6-WK FU were only significant with respect to daily steps and daily aerobic minutes. On the other hand, SCT-grounded mediations at 1-YR FU were only significant with respect to self-reported PA measured by the Godin Leisure-Time Exercise Questionnaire. The discrepancy between mediations on pedometer-based and self-reported PA emphasizes the multidimensional and complex character of PA behavior [113]. In particular, the pedometer-based PA measures referred to all-intensity PA that generate steps and that were performed during the seven-day period before the measurement point. The self-reported PA measure referred mainly to higher intensity PA, whether or not generating steps and performed in a typical week during the month previous to the measurement point.

Cost-effectiveness

In general, the present study has demonstrated that both targeting older adults' personal self by counseling according to SDT and targeting their social self by counseling according to SCT can be effective in promoting their PA, both in the short and in the long run. Nevertheless, prior to translating research into programs that can be implemented in the wider community, the cost-effectiveness of the counseling strategies should be taken into account. Each of the intervention conditions involved weekly contact with a HFS. Consequently, the applied counseling procedures were rather time-consuming and entailed relatively high costs, even though some of the intake sessions took place in groups and five out of the seven contacts occurred by means of an email or a post card. Despite the regular contacts, SI did not involve personalized and individually-tailored counseling, and can therefore be considered as less time-consuming than PI and JI. More specifically, the planning and preparation of the PA counseling in SI took place at the level of the condition, and were therefore irrespective of the number of participants in this intervention condition. This cost-effectiveness makes the socially-oriented counseling strategy especially beneficial to implement in the wider community. The large-scale implementation potential of SI is particularly worth mentioning because

previous research has stated that the most effective PA promoting strategies involve regular face-to-face contact [38].

Results and discussion related to subjective health and well-being

Results related to subjective health and well-being

Intervention effects

The effects of the three PA interventions on subjective health and well-being are shown in Table 5 and Figure 4. With respect to self-rated health, an overall significant change over (3) time was found across the conditions (p = .022) (Table 5). More specifically, self-rated health significantly increased from baseline to 6-WK FU (p < .001, d = 0.29) and from baseline to 1-YR FU (p < .001, d = 0.27). However, contrary to *H3a*, self-rated health significantly increased in SI and JI (baseline to 6-WK FU: SI: p = .010, d = 0.29; JI: p < .001, d = 0.45; baseline to 1-YR FU: SI: p = .004, d = 0.36; JI: p = .001, d = 0.41) but not in PI (baseline to 6-WK FU: PI: p = .256, d = 0.12; baseline to 1-YR FU: PI: p = .788, d = 0.03). This means that only the socially-oriented PA promoting strategies were effective in improving participants' self-rated health.

With respect to physical well-being, the overall change over (3) time across the conditions was not significant (p = .200) (Table 5). Nevertheless, a significant increase was found from baseline to 6-WK FU (p < .001, d = 0.19) and from baseline to 1-YR FU (p = .025, d = 0.14). In particular, and partially supporting *H3b*, physical well-being significantly increased in JI (baseline to 6-WK FU: p < .001, d = 0.38; baseline to 1-YR FU: p = .026, d = 0.28) but not in PI or SI (baseline to 6-WK FU: PI: p = .353, d = 0.08; SI: p = .253, d = 0.11; baseline to 1-YR FU: PI: p = .200, d = 0.14; SI: p = .892, d = 0.01). This finding suggests that, in this sample, a PA promoting program targeting both participants' personal and social self was needed in order to improve their physical well-being.

With respect to psychological well-being, no significant change over (3) time emerged across the conditions (p = .389) (Table 5). Similarly, no significant changes over time were found between two time points, except for the significant increase in JI from baseline to 6-WK FU (baseline to 6-WK FU: overall: p = .470, d = 0.04; PI: p = .365, d = 0.08; SI: p = .159, d = 0.15; JI: p = .031, d = 0.19; baseline to 1-YR FU: overall: p = .526, d = 0.04; PI: p = .929, d = 0.01; SI: p = .887, d = 0.02; JI: p = .230, d = 0.14). This finding demonstrates that PA promotion in which participants' personal and social identity were emphasized had a positive impact on their psychological well-being, but only in the short term.

Irrespective of the average changes in health in each of the conditions, subsequent one-way ANOVAs indicated that participants who improved their self-rated health, physical well-being or psychological well-being had significantly lower baseline levels with respect to these health outcomes compared with those who did not improve their health.

Overall changes over (3) time in self-rated health and well-being did not significantly differ between the intervention conditions (health: p = .297; physical WB: p = .654; psychological WB: p = .124) (Table 5). Moreover, contrast estimates showed no significant differences in changes in physical and

psychological well-being between PI, SI and JI separately from baseline to 6-WK FU and from baseline to 1-YR FU. However, in the long term, i.e. from baseline to 1-YR FU, self-rated health increased significantly more in SI than in PI (t = 2.010, p = .046).

Table 5 Estimated means (SE) for well-being by time and condition

	PI	SI	JI	one-way ANOVA	3 x 3 interaction effect		time effect	
	mean (SE)	mean (SE)	mean (SE)	*F*	*F*	Cohen's *d*	*F*	Cohen's *d*
Self-rated health								
Baseline	5.38 (0.14)	5.31 (0.13)	5.07 (0.13)	1.642				
6-WK FU	5.50 (0.12)	5.58 (0.12)	5.50 (0.12)	0.239	1.238	0.33	3.933*	0.23
1-YR FU	5.41 (0.12)	5.67 (0.13)	5.48 (0.13)	0.672				
Physical well-being								
Baseline	5.09 (0.12)	5.26 (0.11)	5.09 (0.11)	1.013				
6-WK FU	5.15 (0.10)	5.34 (0.10)	5.40 (0.10)	1.641	0.613	0.27	1.628	0.08
1-YR FU	5.19 (0.12)	5.27 (0.11)	5.33 (0.11)	0.910				
Psychological well-being								
Baseline	5.52 (0.09)	5.74 (0.09)	5.55 (0.09)	2.016				
6-WK FU	5.58 (0.09)	5.63 (0.09)	5.66 (0.09)	0.351	1.840	0.22	0.949	0.13
1-YR FU	5.50 (0.010)	5.74 (0.09)	5.63 (0.10)	2.077				

Note. SE, standard error; PI, personal identity condition; SI, social identity condition; JI, joined identity condition; 6-WK FU, six-week follow-up; 1-YR FU, one-year follow-up; 3 x 3 interaction effect, interaction effect over (3) time and between (3) conditions; time effect, overall (3) time effect over the conditions.

*, p < .05; **, p < .01; ***, p < .001

Determinants of subjective health and well-being

Hierarchical regression analyses were conducted to examine the relation between participants' PA, perceived need-support and degree of identification with the PA identity and SOC / IND on the one hand and their self-rated health, physical well-being and psychological well-being at 6-WK FU and at 1-YR FU on the other hand (Table 6). Regression analyses were performed across the intervention conditions. The

proposed model was adjusted for several demographic variables at baseline, i.e. age, gender, relationship status and educational level.

The set of variables entered in the model was significantly related to self-rated health, physical well-being and psychological well-being, with explained variances between 12.7% and 39.0%. Overall, being older and being in a relation were significantly related to higher levels of subjective health and well-being. In addition, the variance in daily steps, but not the variance in daily aerobic minutes or in self-reported PA, was significantly related to the variance in self-rated health and physical well-being at 6-WK FU and at 1-YR FU. This means that taking more steps each day was associated with a higher level of subjective health and physical well-being. Perceived need-support of the coach at 6-WK FU did only contribute to physical well-being at 1-YR FU. Furthermore, the variance in participants' degree of identification with PA and SOC / IND was significantly related to the variance in their self-rated health. This means that a stronger identification with a positive and relevant social identity was related to a higher level of self-rated general health. Similarly, the degree of identification with a PA identity was significantly related to physical well-being at 6-WK FU and 1-YR FU. However, identification with SOC / IND was only related to physical well-being at 1-YR FU. Regression analyses revealed inconsistent results with respect to the relation between participants' degree of identification with the proposed social identities on the one hand and their psychological well-being on the other hand.

Discussion related to subjective health and well-being

Rationale

The main purpose of the present study was to compare the effectiveness of personally- and socially-oriented PA counseling on older adults' PA behavior. However, we did also evaluate the intervention effects on health because of the following three reasons: (1) Regular PA has been shown to positively affect individuals' health and well-being [114,115]. The close relation between PA and health has stimulated us to focus on both outcomes; (2) Previous research has shown the (causal) relationship between SDT-based need-support and SCT-based normative support on the one hand and behavioral change on the other hand [20,68]. However, there is limited empirical evidence for the SDT- and in particular the SCT-grounded assumptions with respect to individuals' health status, i.e. supporting individuals' needs at the personal level and emphasizing their relatedness at the social level are assumed to enhance their health [23,35,45]; and (3) Advanced age has been related to reduced PA behavior as well as to reduced feelings of health and well-being [8,116-118]. In addition, individuals' PA participation and their subjective well-being can be negatively affected by potential lifestyle changes during the late adulthood such as retirement or partner loss [10,119,120]. Given that the sample in this study consisted of adults aged 55 to 70 years, we believed it was useful to assess the intervention effects not only on PA but also on (self-reported) health.

Table 6 Determinants of health and well-being at 6-WK FU and 1-YR FU [a]

	6-WK FU			1-YR FU		
	Self-rated health	**Physical well-being**	**Psychological well-being**	**Self-rated health**	**Physical well-being**	**Psychological well-being**
	β	*β*	*β*	*β*	*β*	*β*
Daily steps	.177***	.139**	.064	.116*	.110**	.035
Need-support	- .032	.030	.059	.009	.083*	- .011
Identification PA	.154**	.351***	.076	.168**	.253***	.079
Identification ID	.249***	.055	.082#	.248***	.362***	.277***
F	15.153**	19.969***	11.018***	11.212***	30.472***	12.134***
R^2	.209	.258	.161	.191	.390	.203
Daily aer. min.	.039	.006	- .027	.041	.046	.027
Need-support	- .035	.012	.048	.007	.073#	- .036
Identification PA	.182***	.381***	.098*	.192***	.271***	.088#
Identification ID	.245***	.054	.078#	.256***	.368***	.278***
F	12.105***	18.684***	10.948***	10.916***	29.557***	12.379***
R^2	.175	.247	.161	.188	.385	.208
Self-reported PA	- .047	.067#	.063	- .013	.003	- .067
Need-support	- .021	.027	.037	.039	.108**	.015
Identification PA	.207***	.376***	.093*	.249***	.335***	.159**
Identification ID	.256***	.059	.049	.242***	.314***	.196***
F	16.904***	20.430***	9.747***	12.808***	28.888***	9.369***
R^2	.220	.254	.127	.197	.357	.152

Note. PA, physical activity; 6-WK FU, six-week follow-up; 1-YR FU, one-year follow-up; Daily aer. min., daily aerobic minutes; Self-reported PA, self-reported physical activity measured by the Godin Leisure-Time Exercise Questionnaire; Identification PA, degree of identification with the physical activity identity; Identification ID, degree of identification with a relevant social identity, i.e. socially engaged persons / independent persons.

a The model, obtained by hierarchical pairwise regression analyses, is adjusted for age, gender, relationship status and educational level at baseline.

*, $p < .05$; **, $p < .01$; ***, $p < .001$; #, $.05 < p < .098$

Changes in health

H3a was partially supported in that self-rated health significantly improved in SI and JI from baseline to 6-WK FU and from baseline to 1-YR FU, but no changes occurred in PI. Moreover, physical well-being significantly increased in JI from baseline to 6-WK FU and from baseline tot 1-YR FU, but no changes emerged in PI and SI. With respect to psychological well-being, a significant improvement could only be observed in JI from baseline to 6-WK FU.

The lack of significant improvements in subjective health in PI is inconsistent with previous SDT-based interventions demonstrating a positive impact of need-supportive PA counseling on individuals' well-being [26,89]. More specifically, an autonomy-supportive PA instructing style has been shown to yield

psychological benefits and improved levels of vitality among middle-aged and older adults [121,122]. Similarly, qualitative research of Lloyd and Little [123] indicated that women perceiving support for their need for autonomy, competence and relatedness in a leisure-time PA context have a greater sense of well-being. The lack of improvements in health in PI indicates that the individually-tailored need-supportive PA promotion was not sufficient to yield enhanced levels of subjective health in this population group, i.e. highly educated and relatively healthy adults aged 55 to 70 years. This result is surprising, especially because participants were initially motivated to participate in a health promoting program and because the HFS particularly attached importance to participants' PA engagement because of its valued outcomes such as health benefits.

The significant improvement in self-rated health in SI is consistent with previous research demonstrating the positive impact of individuals' social identification on their health status [45,51]. For example, a prospective study in California revealed that individuals with a limited social network are twice as likely to die from health problems such as cancer and cardiovascular diseases compared with individuals with multiple meaningful social relationships [124]. Moreover, Glass and colleagues [125] found that categorizing oneself as a socially engaged person reduces the risk of depression among community-dwelling older adults. Group membership has thus not only been recognized as a contributor to health-related behavior such as PA [61,68] but also as a determinant of satisfactory levels of mental health, self-esteem and cognitive functioning.

Despite the improvements in self-rated health, no significant changes emerged in physical and psychological well-being in SI. The different findings with respect to the various health outcomes underscore the multidimensional character of individuals' (subjective) health and well-being. More specifically, physical well-being and psychological well-being referred to specific dimensions of participants' health, i.e. the perceived happiness with their physical fitness and body and the perceived satisfaction with themselves and their lives, respectively. By contrast, self-rated health consisted of a single item referring to participants' perception of their health status in general. In this respect, the improved level of self-rated health in SI suggests that participants understood self-rated health not solely as an evaluation of their physical and psychological health but also an evaluation of their social health. This notion is consistent with the finding that SI increased significantly more in self-rated health from baseline to 1-YR FU than PI. More specifically, the HFS explicitly focused on the relatedness at the social level of the self among participants of SI whereas in PI, the HFS facilitated individuals' relatedness at the personal level of their self. Emphasizing older adults' membership of a positively valued group (e.g., SOC, IND) might thus be effective to enhance their social health, and accordingly their overall self-rated health status.

In JI, improvements did not only emerge with respect to participants' general health but also with respect to the physical and psychological dimensions of their subjective well-being. Therefore, it is suggested that a PA counseling strategy should support both older adults' social relatedness and their personal needs in order to enhance their physical and psychological well-being. However, even though JI improved their self-rated health, physical well-being and psychological well-being whereas SI improved only

their self-rated health and PI improved none of the measured health indices, changes in health were not significantly different between JI on the one hand and PI and SI on the other hand. This is in contrast with *H3b* and can be explained by the homogeneity of the participants' sample as well as by the comparable scores on various health-enhancing factors in PI, SI and JI (e.g., PA increase, perceived need-support, degree of identification with SOC / IND).

Overall, the improvements in health and well-being were relatively small, whether or not significant. These limited changes in health, and accordingly the lack of significant differences in health between the conditions, can be explained by the characteristics of the sample. More specifically, due to the voluntary nature of the study participation, participants were relatively healthy older adults. Consequently, baseline scores for each of the health outcomes were rather high, especially for psychological well-being. Participants felt thus already healthy in general, were already happy with their body appearance and were already satisfied with their life before the start of the PA counseling. Consequently, they were less likely to further enhance their health. The finding that especially participants with worse initial levels of subjective health improved their self-rated health, physical well-being and psychological well-being underscores our interpretation in terms of a ceiling effect.

Even though improvements in self-rated health and physical well-being were relatively small, they did not only emerge immediately after the PA program but also after a one-year follow-up period. This is noteworthy because of the following two reasons: (1) Despite the numerous positive outcomes of PA interventions on health, studies focusing on the sustained effects of PA promoting programs on health and well-being have produced inconsistent results [122,126-128]; and (2) As indicated above, individuals' health and well-being have been found to decline with age. Nevertheless, in this study, scores on self-rated health, physical well-being and psychological well-being were not significantly lower at 1-YR FU compared with baseline in PI, SI or JI. The applied PA promoting programs, either personally-oriented or socially-oriented, can therefore be considered as potential strategies to counteract the age-related decline in psychological health and increased risk of chronic diseases [118,129]. Moreover, given that advanced age can also be associated with adverse health outcomes due to the loss of individuals' group membership (e.g., because of retirement, partner loss, illness) [119,120,130], social identity-based PA counseling may even be more helpful than personally-based PA counseling to maintain satisfactory feelings of well-being among the older adult population.

The (long-term) intervention effects on physical well-being are more explicit than the effects on psychological well-being. This highlights the physical aspect of PA and is consistent with the statement that functional and physical changes are the most direct and salient effects experienced through PA involvement [131,132]. At the same time, the improvements in physical well-being point out the broad-ranging character of physical well-being in that it involves more than avoiding disabilities or diseases. More specifically, it refers to the experience of a good health and physical fitness, the satisfaction with one's body, satisfactory feelings of perceived vitality and the ability to perform habitual tasks without effort [132-134]. Even though the physical character of PA may have resulted in more explicit improvements in physical well-being

compared with psychological well-being, results demonstrated a (post-intervention) increase in the psychological well-being among participants of JI as well. However, the lack of significant improvements in psychological well-being from baseline to 1-YR FU suggests that the six-week PA counseling of JI was insufficient to maintain enhanced levels of psychological well-being over a one-year follow-up period. In this respect, the implementation of booster sessions might be helpful to maintain improved levels of mental health in the long run.

Determinants of health and well-being

In order to contribute to the development of optimal health promoting strategies, we did not only examine the intervention effects on different health outcomes but did also identify determinants of subjective health and well-being. In this respect, and consistent with *H4a*, daily steps were found to be positively related to participants' self-rated health and their physical well-being but not to their psychological well-being. This finding emphasizes the abovementioned physical aspect of PA and, at the same time, suggests that other factors than daily PA are important for older adults to experience a good mental health. This reasoning is supported by the fact that the explained variances with respect to psychological well-being were lower than the explained variances with respect to physical well-being. Besides demographic variables such as age and marital status, previous research has identified the following determinants of quality of life and well-being in older adults: perceived (physical) health status, social reasons, personal goals, leisure-time activities in general and activity-related enjoyment [112,126,128,129,131,134,135].

The finding in the present study that advanced age was positively related to participants' health and well-being is in contrast with previous research [116-118]. In this respect, it should be noted that participants of the present study who were retired were significantly older than those who were not retired (mean age retired participants: 64.20 ± 4.38 years; mean age non-retired participants: 58.96 ± 3.72 years; $F = 58.253$, $p < .001$). Therefore, the older participants of this study were probably engaged more frequently in enjoyable activities compared with the younger participants. As a result, they might have categorized themselves as a member of a variety of (new) social groups, even though they might have lost their work-related identity. These social relationships can have contributed to higher levels of perceived health. In addition, the maximum age of participants in this sample was 70 years. Each of them, including the oldest ones, had a relatively good (physical) health, which might also have contributed to satisfactory feelings of subjective well-being.

PA was differently related to physical and psychological well-being. This is consistent with Diener's [135] statement that subjective health is a multidimensional construct comprising indicators that can be influenced differently. Moreover, contrary to participants' daily steps, neither their daily aerobic minutes nor their self-reported PA measured by the Godin Leisure-Time Exercise Questionnaire were significantly related to their health and (physical) well-being. In this respect, being physically active during the whole day (e.g., active transportation or stair climbing) appears to be more important to perceive a good (physical)

health than engaging in an organized and purposeful PA one or more times a week (e.g., following a dancing class or going for a thirty-minute walk).

Concerning the SDT- and SCT-based assumptions with respect to individuals' health, regression analyses indicated that (1) partially consistent with *H4b*, the need-support of the HFS that was perceived by the participants immediately after the PA intervention did significantly contribute to their physical well-being, but only at 1-YR FU, and (2) consistent with *H4c*, participants' degree of identification with the PA identity and with SOC / IND was significantly related to their self-rated health, their physical well-being and their psychological well-being. These findings suggest that, among this population group, a PA promoting strategy in which individuals' membership of a positively valued group is emphasized is more successful to enhance different dimensions of individuals' health and well-being than a PA promoting strategy in which individuals' personal goals and needs are supported. In this respect, the attainment of the PA goals was probably not the most important determinant of participants' health, even though they were motivated to increase their PA level. On the other hand, the significant contribution of participants' social identification to their subjective health and well-being points out the importance of (at least cognitive) social interactions among older adults. Moreover, the findings suggest that satisfactory feelings of health can be perceived not only by being a physically active person but also by believing to be a physically active person. Nevertheless, previous research has stated that individuals' PA behavior is correlated with their PA identity [62].

General discussion and conclusions

Strengths and limitations

The implementation of a longitudinal intervention with a year-round follow-up period constitutes a first strength of the present study. The use of this *study design* allowed us to examine causality rather than merely cross-sectional associations between PA, subjective health and various predictor variables related to the counseling procedures. The data obtained one year after the intervention are especially valuable considering the SDT- and SCT-grounded assumptions with respect to behavioral persistence. Moreover, the results of the mediation and regression analyses provided insight in the psychological processes leading to increased PA levels and contributing to improved health and well-being. Understanding the working mechanisms of a PA intervention is essential prior to (successful) implementation of the intervention in the wider community.

Second, this study aimed at evaluating two different categories of *outcome variables*: PA-related outcomes (i.e. daily steps, daily aerobic minutes, self-reported PA) and health-related outcomes (i.e. self-rated health, physical well-being, psychological well-being). Studying the intervention effects on both PA and health was particularly meaningful given that providing need-support (which is related to SDT) and providing normative support (which is related to SCT) are not only assumed to facilitate individuals' behavioral performance but also to improve their health and well-being. Furthermore, with respect to the PA-related outcomes, pedometer-based PA as well as self-reported PA was measured. Considering that each of these measurement tools has its limitations [14,113,137], the use of both PA measures provided a

more complete and accurate *PA assessment*. Moreover, by blinding the pedometers, participants were prevented from increasing their PA level because of the motivational feedback that appeared on the device. With respect to the health-related outcomes, we examined the intervention effects on subjective health in general and on the physical and psychological component of well-being. By acknowledging *health as a multidimensional construct*, we gained insight in the influence of the PA intervention on different dimensions of individuals' health status. It should be noted that health and well-being were measured by means of self-reports, which might have led the participants to produce socially desirable answers or to inaccurately interpret some of the questionnaires. However, the validity of assessing individuals' health and well-being based upon a cognitive judgment received support in the literature [131]. More specifically, subjective measures of health have been shown to be more strongly related to outcomes such as life satisfaction than are objective health indices (e.g., level of achievement).

Third, the PA intervention was conducted simultaneously in *two identity branches*. More specifically, the normative support for PA in SI and JI was related to the prototype of two relevant social identities among the older adult population, i.e. SOC and IND. Because both SOC and IND are positively valued identities, each of the participants probably categorized him / herself with those two social groups, at least at some occasions. For example, during a visit in a nursing home, a person can feel socially engaged while pushing along a wheelchair but can feel independent while climbing stairs instead of using the elevator. Nevertheless, the results of the survey indicate that the majority of the participants identified themselves more strongly either with SOC or with IND. This is in line with the different characteristics involved in these social identities, e.g. with respect to the warmth and competence dimension. The differentiation between both identities is supported by the low correlation between participants' degree of identification with SOC and their degree of identification with IND, assessed at the moment of the survey (r = .185, p = .029). Given that changes over time in PA and well-being were not significantly different between SOC and IND, it appears that the effects of the social identity-based PA strategy can be generalized to a variety of relevant and positively valued social identities within this population group.

Despite the promising findings and the abovementioned strengths of the present study, several limitations should be pointed out. First, the *lack of a control condition* prevented us from drawing strong conclusions on the precise impact of the PA counseling procedures relative to participation and measurement effects. Consequently, the magnitude of the intervention effects might have been slightly overestimated. Nevertheless, the large effect sizes and the persistence of the increased PA levels after a one-year follow-up period suggest that the SDT- and SCT-based PA promoting strategies considerably influenced participants' PA pattern. Moreover, mediation analyses demonstrated the mediating role of identified and integrated regulation on participants' PA behavior, which is consistent with the characteristics of the implemented SDT- and SCT-grounded counseling. In addition, previous research on SDT has already provided evidence for the positive impact of different formats of need-supportive counseling on PA behavior among different population groups [14,20]. Specifically, the format of the need-supportive coaching in PI was similar to the format of need-supportive coaching that was implemented

previously and that has been shown to be more effective in increasing individuals' PA than both a control condition receiving no PA instructions and a PA referral [14,36]. In this respect, and in line with the meaning of comparative effectiveness research, this study especially aimed at evaluating whether a socially-oriented PA counseling based on SCT would yield larger increases in PA than a personally-oriented PA counseling based on SDT [64]. Based on the abovementioned reasoning, and despite the lack of a control condition, we believe that each of the theoretically-grounded interventions substantially contributed to the PA increases in PI, SI, and JI. Furthermore, because participants were older adults who were willing to participate in a health-enhancing intervention, we considered it more ethical to provide PA counseling to each of the participants rather than assigning some of them to a no-treatment condition.

The second limitation is related to the *voluntary participation* in the study. At baseline, almost two thirds of the participants could be classified as overweight or obese and only a minority of them attained the step-based recommendations for health as proposed by Tudor-Locke et al. [104,105]. However, due to the self-selection recruitment procedure, participants were relatively healthy and highly educated older adults who were initially motivated to enhance their health, and in particular to increase their PA. This recruitment procedure reduces the generalizability of the findings to adults who belong to a different age category, are in poorer health, have less education and are less motivated to increase their PA level.

It should be noted that the relatively high education (and thus the socio-economic status) of the sample might not only originate from the voluntary character of study participation but also from the format of the preliminary survey. More specifically, the survey, from which participants of the PA intervention were recruited, had a web-based design. According to previous research [138,139], a high socio-economic status, and more specifically a high education, is still one of the most significant determinants of Internet use. In this respect, descriptive analyses on participants' demographic profile indicated that the average number of educational years was 13.98 ± 2.33, with respectively 9.5%, 25.4% and 65.1% of the participants having a primary education, a secondary education and a high education. This exceeds the number of educational years reported in comparable studies on PA promotion among Flemish older adults (i.e. 12.09 ± 2.76 years) [14,140] and is largely above the educational level among Belgian citizens in general (i.e. respectively 31.4%, 37.3% and 31.3% of the Belgian population has a primary education, a secondary education and a high education) [141].

The third limitation concerns the unequal distribution of men and women over the conditions. Even though participants were randomly allocated to the intervention conditions, a smaller *men / women-ratio* was found in PI (i.e. 26.8% men) compared with SI (i.e. 40.4% men) and JI (i.e. 50.0% men) (χ^2 = 6.400, p = .041). Because previous research has shown that a larger proportion of men than women do meet the public health guidelines for PA [6], all analyses were conducted while controlling for gender. Unfortunately, we can not explain the unequal distribution of men and women between the conditions.

Fourth, some of the applied Likert scales were transformed from the original four- or five-point Likert scale to a seven-point Likert scale. Given the recruitment procedure, the sample consisted of a relatively homogenous group of participants, i.e. older adults motivated to enhance their health, and in

particular their PA. In this respect, it was expected that the use of seven-point Likert scales would yield a larger variance with respect to participants' responses. Moreover, because a variety of processes were assessed in the present study, we considered it more appropriate to apply an identical scale for each of them. However, the transformation of some of the original Likert scales to a seven-point Likert scale makes it more difficult to compare the absolute values of the process measures obtained in this study with the values presented in previous research.

Fifth and finally, considering the *weekly contacts* between coach and client, the counseling procedures of the different intervention conditions were relatively time- and labor-intensive. However, in order to reduce the counseling intensity, and accordingly increase the large-scale implementation, only the first (intake) session was face-to-face whereas the following contacts occurred by means of an email conversation or by means of a post card. Moreover, given that the PA counseling in SI was not individually-tailored, postulating identity-based normative support for PA appears to be a particularly potential and valuable health promoting strategy to implement at a large scale. Nevertheless, in addition to this lifestyle approach that aims to directly influence individuals' PA behavior, upstream approaches such as structural environmental changes can be helpful to enhance the population's PA and health. In this respect, building safe bicycle and footpaths may increase the population's active transportation, especially given that cycling and walking are popular types of PA in Flanders.

Conclusions

The present comparative effectiveness study provides evidence for the long-term effectiveness of PA promoting strategies that target older adults' personal self, their social self or both their personal and social self. More specifically, an SDT-based PA counseling in which individually-tailored need-support was provided, an SCT-based PA counseling in which group-based normative support was provided and a joined PA counseling in which both need-support and normative support were provided were shown to be successful in increasing older adults' PA, even after a one-year follow-up period. Moreover, the findings of this study point out the importance of activating a highly qualitative form of behavioral regulation, either identified or integrated, to perform PA behavior in the short and the long term. Considering that proposing group-based PA norms involves a non-individualized approach, this counseling strategy entails relatively low costs. Therefore, socially-oriented PA counseling appears to be particularly beneficial to implement in the wider community compared with individually-tailored need-supportive PA coaching.

With respect to health, the results indicated that PA promotion emphasizing older adults' social sense of self and their membership of a meaningful and positively valued group can positively impact on their subjective health and well-being. Not only being physically active but also believing to be a physically active person has been identified as an important determinant of satisfactory feelings of health.

Overall, it can be concluded that both personally-oriented and socially-oriented PA counseling are fruitful strategies to facilitate behavioral change among older adults whereas a sense of connectedness at the social level of the self appears to be essential to enhance their subjective health. Although this research

needs to be replicated and the role of social norms on behavior change should be further examined, this study constitutes a promising step in the development and (large-scale) implementation of socially-oriented health promoting strategies.

Endnote

Participants were Flemish adults aged 55 to 70 years who did not attain the PA recommendations for health as prescribed by Haskell et al. (2007). They were recruited out of a pool of participants of a web-based survey on self-characteristics of older adults. Recruitment for the web-based survey occurred through adverstisements in local newspapers, internet-based announcements and pamphlets spread via physicians, pharmacists and socio-cultural organizations. Even though recruitment occurred across Flanders, the participants' demographic characteristics slightly differed from those characteristics among the Flemish older population (Table 7) [141,142,143,144]. More specifically, individuals aged 60 to 64 years were overrepresented and male individuals were underrepresented in the participants' sample compared with the Flemish population aged 55 to 70 years. Moreover, individuals with a higher educational level were overrepresented in the sample of the present study compared with the overall Flemish population, and especially compared with the older adult population.

With respect to PA, a slightly higher level of self-reported PA was found in the participants' sample (at baseline) than in the sample of OKRA, which is considered to be representative for the older adult Flemish population with respect to demographic variables. However, it should be noted that results on PA in the present study included all types of PA that lasted for 20 minutes or more, i.e. PA related to sport as well as PA related to household chores or gardening. By contrast, the results on PA that were based on the sample of OKRA only included sport-related PA. Consequently, when taking into account all types of PA, participants of the OKRA-sample would probably be more physically active than those of the present study. Table 7 provides an overview of several demographics and the PA level of the participants' sample compared with those of the Flemish older adult population.

Table 7 Demographic characteristics and PA level of the participants' sample at baseline compared with those of the Flemish (older) population

Characteristic	Participants' sample (n = 169)	Reference group [a]	
Age-related characteristics			
Proportion of individuals aged 55 to 70 years (%)	100		18.3 [2]
Proportion of individuals aged 55 to 59 years (%)	30.2		34.9 [1]
Proportion of individuals aged 60 to 64 years (%)	40.8		31.4 [1]
Proportion of individuals aged 65 to 70 years (%)	29.0		33.7 [1]
Male (%)	39.1		49.3 [1]
Educational level (%) [b]			
Primary	9.5	31.4 [2]	70.0 [3]
Secondary	25.4	37.3 [2]	18.4 [3]
High	65.1	31.3 [2]	11.6 [3]
PA level			
Overall score on Godin Leisure-Time Exercise Questionnaire	19.0		12.8 [3,d]
Proportion of individuals attaining the PA recommendation for health (%) [c]	24.4		14.4 [3,d]

Note. Data are obtained from Federale Overheidsdienst Economie [141,142] and Scheerder et al. [144]. PA, physical activity.

[a] Reference group: [1] Flemish population aged 55 to 70 years (n = 1130177); [2] Entire Flemish population (n = 7241955); [3] Members aged 55 to 70 years of the socio-cultural organization OKRA, considered as representative for the Flemish older adult population with respect to demographic characteristics (n = 949).

[b] A primary educational level refers to a minimum of nine years of education; A secondary educational level refers to a minimum of twelve years of education; A high educational level refers to 15 or more years of education.

[c] An overall score of 27 on the Godin Leisure-Time Exercise Questionnaire corresponds with the physical activity recommendation for health as prescribed by Haskell et al. (2007) (Scheerder et al., 2011).

[d] The score on the Godin Leisure-Time Exercise Questionnaire only included PA related to sport. By contrast, PA related to household chores or gardening was not included in the overall PA score.

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Part 5

Summary and general discussion

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The main purpose of this doctoral thesis was to examine whether the Self-Determination Theory and the Self-Categorization Theory constitute valuable frameworks to promote physical activity among (older) adults who do not attain the physical activity recommendations for health, both in the short and in the long term. In **Part 2** and **Part 3**, we studied the year-round effects of different need-supportive counseling strategies, based on the Self-Determination Theory, on individuals' physical activity behavior. In **Part 4**, we evaluated whether the activation of relevant social identities, based on the Self-Categorization Theory, would produce larger increases in individuals' physical activity than individually-tailored need-supportive counseling.

Besides studying the effects of various physical activity promoting strategies on physical activity behavior, we examined the effects of the theoretically-grounded interventions on (subjective) health and well-being. In addition, we evaluated the social and psychological processes that contributed to the increased physical activity levels and the improved health perceptions. In this respect, we gained insight in the working mechanisms of the physical activity interventions, which is essential prior to implementation in the wider community.

In the present part, i.e. **Part 5**, we will summarize the main findings of the three intervention studies and discuss them in relation to the proposed theoretical frameworks and to previous literature on physical activity promotion. Table 1 provides an overview of the results of the interventions presented in this doctoral thesis. In addition, we will describe practical implications, point out some methodological strengths and limitations of the studies and formulate suggestions for future research.

1. Summary of the main findings

1.1. Physical activity promotion based on the Self-Determination Theory among insufficiently active university employees

The aim of the first intervention study was to examine the effectiveness of a four-month individually-tailored need-supportive physical activity counseling among university employees who do not attain the physical activity recommendations for health. Intervention effects were evaluated on different intensities of physical activity and on physical and psychological well-being immediately after (i.e. four-month follow-up) and one year after the intervention (i.e. one-year follow-up). Participants of the intervention condition (INTERV) received physical activity coaching based on the Self-Determination Theory from a bachelor in Kinesiology. Participants of the control condition (CONTR) did not receive any physical activity advice or coaching.

With respect to physical activity (**Chapter 2.1**), results showed significantly different changes over time between INTERV and CONTR. More specifically, INTERV significantly and substantially increased in moderate and strenuous physical activity from baseline to four-month follow-up and in mild, moderate and strenuous physical activity from baseline to one-year follow-up. In CONTR, no changes emerged with respect to (the different intensities of) physical activity. Self-efficacy and autonomous motivation significantly mediated the intervention effect on (strenuous) physical activity from baseline to four-month

follow-up whereas social support mediated the long-term intervention effect, i.e. from baseline to one-year follow-up.

With respect to subjective well-being (**Chapter 2.2**), the results showed significantly different changes over time between INTERV and CONTR for physical well-being but not for psychological well-being. More specifically, INTERV improved in physical well-being from baseline to four-month follow-up and from baseline to one-year follow-up whereas no changes occurred in CONTR. The intervention effect on physical well-being was mediated by strenuous physical activity. With respect to psychological well-being, no significant changes were found in INTERV or CONTR from baseline to four-month follow-up. However, from baseline to one-year follow-up, a significant decrease emerged in both conditions.

In conclusion, the results of the first intervention study demonstrate the positive impact of an individually-tailored and need-supportive physical activity program on individuals' physical activity behavior and their (physical) well-being, even after a one-year follow-up period. Moreover, they underline the importance of high quality motivation and social support to adopt and maintain physical activity behavior.

1.2. Physical activity promotion based on the Self-Determination Theory among insufficiently active older adults

The aim of the second intervention study was to examine the effectiveness of three physical activity counseling strategies among adults aged 60 years or older who do not attain the physical activity recommendations for health. Intervention effects were studied on pedometer-based and self-reported physical activity and on different indicators of subjective health immediately after (i.e. ten-week follow-up), one year after (i.e. one-year follow-up) and two years after the intervention (i.e. two-year follow-up).

The following three physical activity promoting strategies varying in counseling intensity were compared:

(1) REFER, i.e. a single 15-minute contact in which a Health Fitness Specialist referred participants to local physical activity programs. This physical activity promoting strategy was considered as a minimal intervention condition because neither an individualized physical activity program nor an individually-tailored need-supportive coaching was provided.

(2) WALK, i.e. a single 15-minute contact in which a Health Fitness Specialist provided participants a structured program consisting of walking schemes that gradually increased in walking volume and intensity. The structured format and gradually increasing difficulty of the program were assumed to implicitly facilitate participants' need for competence. Therefore, this physical activity promoting strategy was considered to be a partially need-supportive counseling procedure;

(3) COACH, i.e. a ten-week multiple-contact individually-tailored physical activity counseling in which a Health Fitness Specialist facilitated participants' needs for autonomy, competence and relatedness.

With respect to physical activity (**Chapter 3.1**), each of the intervention conditions significantly and substantially increased in daily steps and self-reported physical activity from baseline to ten-week follow-up. However, WALK and COACH yielded (significantly) larger increases in physical activity than REFER. Similarly, each of the conditions significantly increased in self-reported physical activity from baseline to one-year follow-up, with larger increases in WALK and COACH than in REFER. With respect to daily steps from baseline to one-year follow-up, no significant time by condition interaction effect emerged, but however, significant increases were found in WALK and COACH whereas no changes emerged in REFER. The relation between participants' perceived need-support and their physical activity level was mediated by their autonomous motivation, irrespective of intervention condition.

With respect to the different indicators of subjective health (**Chapter 3.2**), results showed no significantly different changes over time between the intervention conditions. However, each of the intervention conditions significantly improved in subjective well-being and trait anxiety, both from baseline to ten-week follow-up and from baseline to one-year follow-up. From baseline to two-year follow-up, no changes emerged in subjective well-being, indicating a relapse to baseline level two years after the intervention. Similarly, trait anxiety significantly increased from baseline to two-year follow-up. Participants' improvements in well-being and trait anxiety were significantly predicted by their increases in physical activity. In addition, a higher level of perceived need-support of the coach significantly contributed to a better subjective health, but only at ten-week follow-up and one-year follow-up.

In conclusion, the results of the second intervention study demonstrate the year-round effectiveness of three physical activity promoting programs varying in counseling strategy on older adults' physical activity and on their subjective well-being. However, an individualized and (partially) need-supportive physical activity program seems to be more successful in producing long-term physical activity engagement than referral to widespread physical activity opportunities. Furthermore, the findings point out the key role of autonomous motivation in the transition from an inactive to regularly active lifestyle in older adults. At the same time, an increased physical activity level and satisfactory feelings of perceived need-support emerged as important determinants of older adults' subjective health over a one-year follow-up period. However, these determinants appear to be insufficient to maintain the enhanced levels of mental health over a longer period of time.

1.3. Physical activity promotion based on the Self-Categorization Theory among insufficiently active older adults

The aim of the third intervention study was to examine the effectiveness of three six-week identity-based physical activity counseling strategies among adults aged between 55 and 70 years who do not attain the physical activity recommendations for health. Intervention effects were studied on pedometer-based and self-reported physical activity and on different indicators of subjective health and well-being immediately after (i.e. six-week follow-up) and one year after the intervention (i.e. one-year follow-up).

The following three counseling procedures were compared:

(1) An individually-tailored physical activity coaching based on the Self-Determination Theory and targeting participants' personal identity (i.e. personal identity condition; PI). A Health Fitness Specialist supported participants' needs for autonomy, competence and relatedness at the personal level of the self;

(2) A physical activity promoting strategy based on the Self-Categorization Theory and targeting participants' social identity (i.e. social identity condition; SI). A Health Fitness Specialist provided group-based normative support for physical activity;

(3) A physical activity counseling procedure based on both the Self-Determination Theory and the Self-Categorization Theory (i.e. joined identity condition; JI). A Health Fitness Specialist facilitated participants' physical activity behavior by targeting both their personal and their social identity.

With respect to physical activity (**Chapter 4.1**), significant and substantial increases in daily steps, daily aerobic minutes and self-reported physical activity were found in PI, SI and JI, both from baseline to six-week follow-up and from baseline to one-year follow-up. Changes over time were not significantly different between the intervention conditions, except for aerobic minutes. More specifically, SI increased significantly more in aerobic minutes from baseline to six-week follow-up than PI. Furthermore, the relations between perceived need-support and perceived normative support on the one hand and physical activity on the other hand were mediated by identified regulation and integrated regulation, respectively.

With respect to the different indicators of subjective health and well-being (**Chapter 4.1**), results showed significant increases in self-rated health in SI and JI from baseline to six-week follow-up and from baseline to one-year follow-up whereas no changes emerged in PI. Moreover, physical well-being significantly increased in JI from baseline to six-week follow-up and from baseline tot one-year follow-up whereas no changes occurred in PI and SI. With respect to psychological well-being, a significant improvement was demonstrated in JI from baseline to six-week follow-up whereas no changes emerged in PI and SI. Participants' self-rated health and physical well-being were significantly related to their daily steps, but however not to their daily aerobic minutes or self-reported physical activity. In addition, participants' perceived need-support contributed to their physical well-being, but only at one-year follow-up. Finally, participants' degree of identification with a relevant social identity was significantly related to each of the proposed dimensions of their subjective health, i.e. their self-rated health, physical well-being and psychological well-being.

In conclusion, the results of the third intervention study provide evidence for the long-term effectiveness of physical activity promoting strategies that target individuals' personal self, their social self or their personal and social self. More specifically, both individually-tailored need-supportive counseling and providing group-based normative support for physical activity were shown to be successful in increasing physical activity among the older adult population, even after a one-year follow-up period. Demonstrating highly qualitative behavioral regulation, either identified or integrated, appeared to be

essential to perform physical activity in the short and the long term. With respect to health, the results indicated the importance of emphasizing older adults' membership of a meaningful group in order to positively affect their subjective health and well-being. Hence, it seems that not only being but also perceiving oneself as a physically active person is related to satisfactory levels of well-being.

2. General discussion

2.1. Discussion of the findings and practical implications

2.1.1. Discussion of the findings related to Self-Determination Theory-based physical activity promotion

Each of the studies presented in this doctoral thesis provides evidence for the positive impact of physical activity promotion grounded in the Self-Determination Theory on (older) adults' physical activity level. In this respect, it is suggested that individuals' physical activity behavior can be facilitated by supporting their need for autonomy (e.g., by exploring physical activity options rather than prescribing physical activities), their need for competence (e.g., by drafting a structured and appropriate physical activity plan) and their need for interpersonal relatedness (e.g., by creating a warm relationship within an empathetic environment).

The behavioral changes that resulted from the need-supportive physical activity counseling are consistent with the assumptions proposed by the Self-Determination Theory as well as with Self-Determination Theory-based literature within the domain of physical activity promotion (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). For example, Wilson and colleagues (2005) demonstrated that adolescents who had participated in a four-week need-supportive physical activity program spent more time in moderate and strenuous intensity physical activity whereas no changes in physical activity behavior emerged in the comparison group who had participated in a standard health education program.

In addition, the Self-Determination Theory-based physical activity promoting strategies presented in this thesis contribute to the literature, both from a theoretical and a practical perspective. A number of notable findings are discussed below, together with their practical implications.

Table 1. Summary of the results reported in this doctoral thesis

	INTERVENTION STUDY 1	**INTERVENTION STUDY 2**									**INTERVENTION STUDY 3**					
	SDT-based PA promotion among university employees	SDT-based PA promotion among Flemish adults aged ≥ 60 years									SDT- and SCT-based PA promotion among Flemish adults aged 55-70 years					
Intervention effects																
Intervention conditions	Need-supportive counseling	PA referral			Provision of structured walking program			Need-supportive counseling			Personal identity-based counseling		Social identity-based counseling		Joined identity-based counseling	
Measurement point	4-mth FU	1-yr FU	10-wk FU	1-yr FU	2-yr FU	10-wk FU	1-yr FU	2-yr FU	10-wk FU	1-yr FU	2-yr FU	6-wk FU	1-yr FU	6-wk FU	1-yr FU	6-wk FU	1-yr FU
PA																	
Self-reported PA																	
Mild PA	0	↑	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Moderate PA	↑	↑	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strenuous PA	↥	↥	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total GLTE-score	↥	↥	↑	↥	↑	↥	↥	↥	↥	↥	↥	↥	↥	↥	↑	↥	↥
Pedometer-based PA																	
Daily steps	-	-	↑	0	-	↑	↑	-	↑	↑	-	↥	↥	↥	↥	↥	↥
Daily aerobic minutes	-	-	-	-	-	-	-	-	-	-	-	↥	↥	↥	↥	↥	↥
Health and WB																	
Self-rated health	-	-	-	-	-	-	-	-	-	-	-	0	0	↑	↑	↑	↑
Subjective WB	-	-	↑	↑	0	↑	↑	0	↑	↑	0	-	-	-	-	-	-
Physical WB	↥	↑	-	-	-	-	-	-	-	-	-	0	0	0	0	↑	↑
Psychological WB	0	↓	-	-	-	-	-	-	-	-	-	0	0	0	0	↑	0
Trait-anxiety	-	-	↓	↓	↑	↓	↓	↑	↓	↓	↑	-	-	-	-	-	-

Table 1. Summary of the results (continued)

Processes							
Intervention study	**SDT-based PA inter-vention**		**SDT-based PA intervention**			**SDT- and/or SCT-based PA intervention**	
Time frame	4-mth FU	1-yr FU	10-wk FU	1-yr FU	2-yr FU	6-wk FU	1-yr FU
Mediators of PA							
Social support	ns M	M_{GLTE}	-	-	-	-	-
Self-efficacy	$M_{str/GLTE}$	ns M	-	-	-	-	-
Autonomous motivation	M_{str}	ns M	$M_{steps/GLTE}$	$M_{steps/GLTE}$	-	-	-
Identified regulation	-	-	-	-	-	$M_{steps/aer}$	$M_{steps/aer}$
Integrated regulation	-	-	-	-	-	$M_{steps/aer}$	M_{GLTE}
Determinants of health and WB							
Mild PA	ns M	M_{phys}	-	-	-	-	-
Moderate PA	ns M	ns M	-	-	-	-	-
Strenuous PA	M_{phys}	M_{phys}	-	-	-	-	-
Total GLTE-score	-	-	C_{subj}	$C_{subj/anx}$	C_{subj*}	C_{phys*}	ns C
Daily steps	-	-	-	-	-	$C_{health/phys}$	$C_{health/phys}$
Daily aerobic minutes	-	-	-	-	-	ns C	ns C
Need-support	-	-	C_{subj}	$C_{subj/anx*}$	ns C	ns C	C_{phys}
Social identification	-	-	-	-	-	$C_{health/phys/psych}$	$C_{health/phys/psych}$

Note. SDT, Self-Determination Theory; SCT, Self-Categorization Theory; PA, physical activity; WB, well-being; GLTE-score, score on Godin Leisure-Time Exercise Questionnaire; 10-wk FU; ten-week follow-up; 4-mth FU, four-month follow-up; 1-yr FU, one-year follow-up; 2-yr FU, two-year follow-up; 0, no significant change in outcome variable from baseline to the particular measurement point; ↑ (↓), significant increase (decrease) in outcome variable from baseline to the particular measurement point; ↑ (↓), small effect size (Cohens' d < 0.5); **↑** (**↓**), medium effect size (0.5 ≤ Cohens' d < 0.8); **↥** (**↧**), large effect size (Cohens' d ≥ 0.8); ns M, did not significantly mediate the relation between need-support and the outcome variables; $M_{str/GLTE/steps/aer/phys}$, significantly mediated the relation between need-support and strenuous physical activity / self-reported physical activity measured by the Godin Leisure-Time Exercise Questionnaire / daily steps / daily aerobic minutes / physical well-being; ns C, did not significantly contribute to the outcome variables; $C_{subj/anx/health/phys/psych}$, significantly contributed to subjective well-being / trait-anxiety / self-rated health / physical well-being / psychological well-being; significance level set at $p < .05$; * $p < .10$

2.1.1.1. Intervention effects on physical activity

a) Persistence and size of the intervention effects

Based on the results with respect to physical activity (Table 1), we can draw the following two conclusions:

(1) *The implemented interventions did work*. More specifically, the results demonstrated that each of the need-supportive counseling strategies yielded measurable and *significant increases* in participants' physical activity, both in the short and in the long term;

(2) *The implemented interventions worked (very) well*. More specifically, moderate to (very) *large effect sizes* were observed with respect to each of the need-supportive physical activity interventions, both in the short and in the long term.

The maintenance of the increased physical activity levels after a period of one year is especially remarkable considering the limited evidence for *long-term effects* of physical activity promoting strategies (Van Der Bij, Laurant, & Wensing, 2002). The employment of an underlying theoretical framework, and in particular the use of the Self-Determination Theory, might have played an important role in the attainment of sustained intervention effects on participants' physical activity behavior (Glanz & Bishop, 2010; Hillsdon, Foster, Cavill, Crombie, & Naidoo, 2005). More specifically, and as indicated previously, this theory on behavioral change assumes that supporting individuals' basic psychological needs facilitates self-determined motivation and accordingly yields behavioral persistence. However, despite this assumption, studies on need-supportive physical activity promotion have rarely conducted follow-up assessments after a longer period of time (Silva et al., 2010a; Teixeira et al., 2012). By focusing on both the adoption and the persistence of participants' physical activity engagement, the studies presented in this thesis provided empirical support for the Self-Determination Theory within the physical activity domain. Furthermore, the (long-term) physical activity increases that emerged in the studies of this thesis were not only consistent with the assumptions related to the Self-Determination Theory but also with those related to the Goal-setting Theory of Locke and Latham (1990). In particular, the need-supportive counseling procedures entailed either individualized physical activity goal-setting or the provision of structured, concrete and realistic physical activity schemes, which are, according to the Goal-setting Theory, essential to change individuals' behavior.

With respect to the magnitude of the effects, each of the studies reported large to very large *effect sizes*. For example, self-reported physical activity increased with 50% to 100% relative to baseline scores, even after a one-year follow-up period. Similarly, in the need-supportive intervention condition of Study 3, the total number of daily steps increased with 65% to 75% relative to baseline levels. This corresponds with an increase of 3000 to 3600 steps a day. In the (partially) need-supportive conditions of Study 2, the increases in daily steps relative to baseline levels were somewhat smaller, i.e. 22% or about 1300 steps per day post-intervention and 8% or about 500 steps per day at one-year follow-up. The increases in daily steps were (still) considerably larger than the average increases reported in pedometer-based literature on

(older) adults (Tudor-Locke et al., 2011a). More specifically, changes of 775 steps per day and 2000 to 2500 steps per day are considered to be typical immediately after a physical activity program in older and younger adults, respectively (Tudor-Locke et al., 2011a, 2011b).

Overall, the effect sizes observed in the Self-Determination Theory-based interventions presented in this thesis are large compared to the effect sizes reported in other effective psychological interventions (i.e. .20 to .40) (Hunter & Schmidt, 1990). Measurement and participation effects may have, to some extent, contributed to these large increases in physical activity. However, the largeness of the effect sizes, the year-round maintenance of the increased physical activity levels and the improvements in theoretically-grounded process variables suggest a substantial impact of the need-supportive counseling on participants' physical activity behavior as well.

With respect to physical activity interventions that are particularly grounded in the Self-Determination Theory, previous research has reported effect sizes of time by condition interactions, when need-supportive physical activity counseling was compared with general health education. Overall, moderate to large effect sizes have been indicated, favoring the need-supportive program (e.g., Edmunds, Ntoumanis, & Duda, 2008; Silva et al., 2010a). This provides support for the potential of need-supportive counseling to facilitate physical activity engagement. Nevertheless, previous Self-Determination Theory-based studies have rarely reported effect sizes with respect to the physical activity changes over time that result from the implemented physical activity programs separately. Moreover, studies that did indicate the extent of the effects of need-supportive counseling on physical activity showed inconsistent results (Barbeau, Sweet, & Fortier, 2009; Edmunds, Ntoumanis, & Duda, 2007; Moustaka, Vlachopoulos, Kabitsis, & Theodorakis, 2012; Teixeira et al., 2012; Wilson, Rodgers, Blanchard, & Gessell, 2003). This inconsistency may have resulted from the procedural differences with respect to the study design, e.g. intervention duration, population sample, applied physical activity assessment tools, baseline levels of physical activity, format of provided need-support etc.

Besides studying the size of the physical activity increases, we evaluated the changes in individuals' physical activity behavior in terms of the *recommended physical activity level for health*. Most studies have merely focused on the average changes in physical activity levels that are produced by a physical activity program. In this respect, understanding the physical activity increases from a health promoting perspective contributes to the literature on physical activity promotion. In each of the three intervention studies presented in this doctoral thesis, a considerably larger proportion of participants attained the physical activity health recommendation at follow-up compared with baseline. For example, the proportion of participants who attained a score of 27 on the Godin Leisure-Time Exercise Questionnaire increased from 10-20% at baseline to 50-60% at one-year follow-up. Similarly, whereas almost none of the participants of Study 3 took 7500 steps each day before the intervention, more than half of them attained this threshold one year after the intervention. Despite the variety of physical activity recommendations, these findings highlight the potential of need-supportive physical activity counseling to positively impact on individuals' physical activity behavior as well as on public health in general.

The potential of need-supportive strategies to increase physical activity participation at population level is strengthened by the demonstrated effectiveness of all three Self-Determination Theory-based interventions presented in this thesis. More specifically, the results of the implemented physical activity programs point out that supporting individuals' needs for autonomy, competence and relatedness can increase physical activity engagement among *younger as well as among older adults*. These findings corroborate and extend previous research on need-supportive physical activity promotion, which has mainly targeted adolescents and younger adults (Teixeira et al., 2012).

Nevertheless, despite the demonstrated effectiveness of need-supportive physical activity coaching among individuals belonging to different age ranges, the results indicated that participants who increased their physical activity level had significantly *lower baseline scores of physical activity* than those who had not increased their physical activity. For example, participants of Study 3 who had increased their daily steps from baseline to one-year follow-up attained on average 5000 steps at baseline whereas participants who had not increased their daily steps during this time period had an average of 6345 steps at baseline. Implementing a physical activity program that is grounded in the Self-Determination Theory appears thus to be especially promising to help those individuals who might benefit the most from a more active lifestyle.

b) Specification of the intervention effects

Each of the need-supportive interventions yielded increases in individuals' physical activity level, irrespective of the applied measurement tool for physical activity. This suggests that the need-supportive programs were effective in increasing *different dimensions and types of physical activity*. More specifically, this finding demonstrates the potential of Self-Determination Theory-based physical activity promoting strategies to increase both individuals' purposeful leisure-time physical activities and their non-purposeful habitual physical activities. The positive influence of need-supportive counseling on different dimensions of physical activity is noteworthy because previous physical activity promoting studies that are grounded in the Self-Determination Theory have usually evaluated physical activity behavior relying on only one measure (Teixeira et al., 2012). Specifically, most studies did employ self-report instruments whereas only a minority of them used pedometers or accelerometers to measure individuals' physical activity.

Irrespective of the type of the performed physical activities, the need-supportive counseling particularly affected individuals' engagement in *higher intensity* physical activities. More specifically, the first intervention study demonstrated post-intervention increases in moderate and strenuous intensity physical activity whereas no changes emerged in mild intensity physical activity. In order to distinguish between different intensities of physical activity behavior, sophisticated measurement tools such as accelerometers or specific self-report instruments are needed. As indicated above, most research on Self-Determination Theory-based physical activity promotion has evaluated participants' physical activity by means of self-reports (Teixeira et al., 2012). In particular, numerous studies applied the Godin Leisure-Time Exercise Questionnaire, which asks for individuals' engagement in mild, moderate and strenuous intensity

physical activities separately. However, most studies have reported a total score of physical activity or have only focused on strenuous physical activity (Edmunds, Ntoumanis, & Duda, 2006; Teixeira et al., 2012). Therefore, the first intervention study of this thesis, which evaluated the impact of need-supportive physical activity counseling on different intensities of physical activity, can be considered as particularly valuable within the domain of Self-Determination Theory-grounded physical activity promotion.

The positive impact of need-supportive coaching on individuals' engagement in higher intensity physical activity is particularly favorable because performing higher intensity physical activities has been found to produce greater aerobic and cardioprotective benefits than performing lower intensity physical activities (Swain & Franklin, 2006; Williams, 1998). In addition, engagement in higher intensity physical activities has been shown to be maintained over a longer period of time than engagement in lower intensity physical activities, which optimizes the attainment of health benefits even more (King, Rejeski, & Buchner, 1998).

In conclusion, literature on physical activity promotion has provided support for the effectiveness of a variety of physical activity programs in increasing individuals' physical activity behavior. However, the findings presented in this doctoral thesis suggest that applying an underlying cognitive framework, and in particular the Self-Determination Theory, can enlarge the effectiveness and the public health impact of a physical activity promoting strategy. More specifically, the three intervention studies demonstrated that a need-supportive physical activity program can yield physical activity increases that are particularly large and maintained over a longer period of time. Moreover, this type of counseling seems to impact especially on individuals' engagement in higher intensity physical activities and to positively affect individuals' physical activity behavior both during their daily life and during their leisure time. In addition, a physical activity program that supports individuals' basic psychological needs appears to be effective in increasing physical activity levels up to the health recommendations among different age groups, and can therefore be considered as a potential strategy to improve public health. Policy makers should thus be encouraged to support the implementation of Self-Determination Theory-based physical activity interventions in order to increase physical activity engagement at population level.

2.1.1.2. Physical activity promoting strategies

a) Format of the physical activity promoting strategies

As mentioned above and consistent with the literature, the results presented in this thesis indicated that a *physical activity program facilitating individuals' personal needs for autonomy, competence and relatedness* can successfully increase their physical activity level, both in the short and in the long term. Previous research on physical activity promotion has even shown that need-supportive counseling is a more successful strategy to increase individuals' physical activity engagement than general health education or a standard counseling / teaching style in which choices, rationale and expectations are limited, goals are not set and minimal feedback is provided (e.g., Chatzisarantis & Hagger, 2009; Silva et al., 2010a; Wilson et al.,

2005). The findings of the second intervention study support this conclusion. More specifically, Study 2 of this thesis demonstrated that the non-theoretically-grounded provision of a booklet with practical information on local physical activity opportunities is effective in increasing older adults' physical activity level, but however less effective than the provision of a (partially) need-supportive program or counseling strategy. Consequently, and as stated in previous research, approaching individuals personally and supporting their basic psychological needs appear to be important to successfully help them to adopt and in particular to maintain physically active behavior (Dacey, 2005; Stathi, McKenna, & Fox, 2003; Taylor et al., 2004; Teixeira et al., 2012).

At the same time, the findings of the intervention studies indicate that behavioral changes within the physical activity domain can be obtained by *supporting individuals' personal needs in different ways*. More specifically, the results of the second intervention study demonstrated similar physical activity increases among participants who had received a structured physical activity program that *inherently* supported their basic psychological needs and among participants who had received a physical activity counseling that *explicitly* supported their personal needs. This finding suggests that providing need-support implicitly and providing need-support explicitly can equally impact on individuals' physical activity behavior, both in the short and in the long term. To our knowledge, previous research on physical activity promotion has not yet compared the effects of supporting individuals' basic psychological needs explicitly and implicitly. Nevertheless, providing a physical activity program that inherently supports individuals' personal needs may reduce the costs that are associated with the physical activity promoting strategy, and accordingly may increase the potential to implement the program at a large scale.

Moreover, the similar effects on physical activity of the two need-supportive strategies tested in Study 2 also suggest that facilitating only *one psychological need* can be equally effective as facilitating each of the *three needs* in increasing individuals' physical activity level. This is consistent with previous research stating that supporting only one need proposed by the Self-Determination Theory can be sufficient to yield positive outcomes (Dunn, Andersen, & Jakicic, 1998; Haerens et al., 2013; Stewart et al., 2001). More specifically, a Self-Determination Theory-grounded study in a school context indicated that individuals do not make a distinction between the perceptions of the different needs but rather perceive need-support in general (Haerens et al., 2013; Vansteenkiste, Niemiec, & Soenens, 2010). In this respect, it appears that perceiving or providing support for one of the psychological needs entails the support for the other needs as well (Vansteenkiste et al., 2010). In particular, participants might have perceived autonomy support and relatedness support as a result of the perceived competence support that was implicit to the structured walking program. The strong correlation between the three personal needs in the particular intervention conditions provides support for this reasoning.

The provision of need-support did not only vary with respect to the degree of explicitness and the number of psychological needs that were facilitated but also with respect to the way of *communication*. More specifically, participants' personal needs were facilitated either verbally (e.g., during face-to-face contacts or during contacts by phone) or non-verbally (e.g., through email conversations or by illustrated

post cards). Different communication modes can thus be employed to successfully translate the tenets proposed by Self-Determination Theory into a need-supportive language. This increases the implementation potential of need-supportive physical activity promotion at a large scale.

Finally, the need-supportive physical activity interventions presented in this thesis did, to some extent, vary with respect to the *intensity* with which they fulfilled participants' psychological needs. More specifically, the need-supportive programs involved either a single-contact intervention or a multiple-contact counseling procedure. Each of the physical activity programs yielded increases in participants' physical activity level, suggesting the equal potential of more and less time-consuming need-supportive counseling to promote physical activity. This is in contrast with Fortier, Sweet, O'Sullivan, and Williams (2007), who concluded that patients receiving brief ánd intensive autonomy-supportive counseling showed higher levels of physical activity at 13 weeks compared with patients receiving only brief autonomy-supportive counseling from their health care provider. It remains an open question whether or not these different findings are caused by procedural differences between our studies and theirs, such as the intervention duration (i.e. 15 minutes vs. 2-4 minutes), the format of the provided program (i.e. a ten-week structured physical activity plan vs. a one-month physical activity prescription based on a formulated goal), the role of the counselor (i.e. a Health Fitness Specialist vs. a health care provider) etc.

b) Physical activity counselors

Besides the diversity with respect to their format, the need-supportive physical activity programs that were implemented in one of the studies varied with respect to the *number and role of the counselors*. More specifically, 30 bachelors in Kinesiology operated as a physical activity coach in the first need-supportive study whereas respectively three and one Health Fitness Specialists (MSc) operated as physical activity coach in the second and third intervention study. The large number of counselors applied in Study 1 resulted in more *room for interpretation* of the theoretical tenets, and accordingly more differentiation in the translation of the Self-Determination Theory into practice. Nevertheless, each of participants gave moderate to high scores on perceived need-support of the coach in each of the studies (minimum scores: 3.38 on a five-point Likert scale in Study 1; 3.04 on a five-point Likert scale in Study 2; and 4.50 on a seven-point Likert scale in Study 3) suggesting that all coaches succeeded in supporting participants' needs for autonomy, competence and relatedness. Moreover, each of the need-supportive counseling strategies positively affected participants' physical activity behavior, both in the short and the long term.

These findings provide support for the statement that the Self-Determination Theory is a suitable framework not only for scientific research but also for practical discourses (Patrick & Williams, 2012). More specifically, this theory allows room for interpretation, meaning that counselors can apply the theoretical principles in accordance with the situation, the client and their own personality.

Nevertheless, and consistent with previous research on need-supportive physical activity promotion (e.g., Fortier, Sweet, O'Sullivan, & Williams, 2007; Silva et al., 2010a), each of the coaches was an *expert* either in health (care), exercise or psychology. Moreover, each of the physical activity coaches

received an additional and *specific training* on applying the Self-Determination Theory within a physical activity promoting context. This suggests that both an appropriate education on health and / or physical activity ánd an additional training on Self-Determination Theory-based coaching are needed to successfully implement a need-supportive physical activity program.

In conclusion, consistent with previous research, the findings presented in this thesis provide empirical evidence for the value of the Self-Determination Theory within the domain of physical activity promotion. In addition, they provide support for the successfulness of need-supportive physical activity counseling to increase individuals' physical activity compared to standard physical activity counseling. Moreover, the results of the three intervention studies contribute to the literature by demonstrating that need-supportive strategies varying with respect to their format, and accordingly their counseling intensity were equally effective in facilitating behavioral change. More specifically, substantial short- and long-term increases in physical activity emerged after implementing a physical activity intervention that supported only one need instead of three needs, that provided need-support inherent to the program instead of explicitly, that facilitated individuals' basic needs in a non-verbal way instead of a verbal way and that involved a single need-supportive contact instead of a multi-contact counseling procedure. In addition, the results pointed out that applying the Self-Determination Theory allows room for interpretation, and can thus be successfully employed by each expert in health or physical activity, albeit after receiving a specific training. This wide range of opportunities to successfully implement a Self-Determination Theory-based physical activity program enlarges the potential to develop an effective but low-cost physical activity promoting strategy, and accordingly to positively affect physical activity behavior not only at the individual but also at the population level.

2.1.1.3. Working mechanisms

Besides studying the effectiveness of the physical activity promoting strategies, we evaluated the role of various psychological processes related to the Self-Determination Theory. In particular, we examined the mediating influence of *self-determined forms of behavioral regulation* on the relation between participants' perceived need-support and their physical activity behavior. Only a minority of previous studies grounded in the Self-Determination Theory have investigated mediating influences (Fortier, Duda, Guerin, & Teixeira, 2012; Silva et al., 2010b; Teixeira et al., 2012), even though conducting mediation analyses is important to develop and implement fruitful physical activity promoting strategies. More specifically, it does not only enable the researcher to test the assumptions postulated by the theoretical framework but also to understand the underlying mechanisms of the physical activity programs.

Irrespective of the type of the physical activity promoting strategy, self-determined behavioral regulation was found to mediate the relation between participants' perceived need-support and their physical activity level. More specifically, higher levels of perceived need-support of the coach were associated with higher levels of physical activity through higher levels of self-determined motivation. The

mediating role of self-determined behavioral regulation on the relation between need-support and physical activity is consistent with the tenets of the Self-Determination Theory (Deci & Ryan, 1985) and with previous literature on need-supportive physical activity promotion (Barbeau et al., 2009; Chatzisarantis & Hagger, 2009; Fortier et al., 2007; Silva et al., 2010a; Teixeira et al., 2012).

The mediating influences were identified in both a *longitudinal* and a *cross-sectional* way. This allowed us to draw conclusions on the causal relationship between the variables rather than merely studying cross-sectional relations. Specifically, the results of Study 1 showed a significant mediation based on difference scores and the results of Study 2 and Study 3 showed a significant mediation based on absolute scores. However, in Study 2 and Study 3, mediation was not only observed immediately after but also one year after the intervention. This is noteworthy and indicates that participants' perceived need-support immediately after a physical activity intervention can influence their degree of self-determined regulation and their physical activity behavior in the long term, i.e. one year after the intervention.

Furthermore, mediating influences of behavioral regulations emerged on both self-reported and pedometer-based physical activity, and accordingly on *different types and intensities of physical activity*. This is in contrast with Silva et al. (2010a) who demonstrated a positive influence of self-determined motivation only on higher intensity physical activities. The question remains whether those different results can be explained by the different types of self-determined behavior that were evaluated in each of the studies. More specifically, the studies presented in this thesis tested the mediating role of identified regulation or of autonomous motivation based on both identified regulation and intrinsic motivation. By contrast, Silva et al. (2010b) tested the mediating influence of intrinsic motivation. In this respect, the findings of both studies are consistent with Wilson, Rodgers, and Fraser (2002) who found that mild intensity physical activities were predicted by identified regulation only whereas moderate en strenuous intensity physical activities were predicted by both identified regulation and intrinsic motivation. This suggests that the various forms of behavioral regulation can impact on individuals' physical activity behavior in a different way.

Overall, the results supported the positive relations between greater perceived need-support, more self-determined types of motivation and higher physical activity levels, and accordingly provided empirical evidence for the tenets of the Self-Determination Theory. Consistent with previous need-supportive research within the domain of physical activity promotion (Fortier et al., 2007), *explained variances* of about 20% were observed. They even went up to 30%, albeit with slight differences between the respective studies and the applied assessment tools for physical activity. Self-determined (types of) motivation can thus be considered as an important element of (continued) physical activity engagement.

In conclusion, the abovementioned findings demonstrate the applicability of the Self-Determination Theory to obtain health, and in particular physical activity, behavioral changes. Therefore, physical activity promoting strategies should aim at supporting individuals' needs for autonomy, competence and relatedness in order to facilitate highly qualitative forms of motivation, and accordingly physical activity adoption and maintenance. More specifically, individuals should be encouraged to engage in physical activity because of its personally valued outcomes or for their own sake.

2.1.1.4. Health impact of need-supportive physical activity counseling

Considering the health-related assumptions proposed by the Self-Determination Theory, the studies presented in this thesis did examine the impact of the need-supportive physical activity programs not only on participants' behavior but also on their health perception. The improvements in anxiety and in, particularly physical, well-being that emerged in Study 1 and Study 2 are consistent with the tenets of the Self-Determination Theory as well as with Self-Determination Theory-based literature on health and well-being (Ryan & Deci, 2000; Vansteenkiste et al., 2010). For example, previous research has demonstrated psychological benefits among (older) adults after participating in an autonomy-supportive physical activity program (Moustaka et al., 2012; Solberg, Hopkins, Ommundsen, & Halvari, 2012). Similarly, qualitative research of Lloyd and Little (2010) indicated that women perceiving support for their needs for autonomy, competence and relatedness in a leisure-time physical activity context have a greater sense of well-being. Besides providing support for the findings of previous need-supportive studies, the results presented in this thesis contribute to the literature by showing positive effects on well-being after a one-year follow-up period as well.

Based on the findings presented in Study 1 and Study 2, and as suggested above, we can conclude that need-supportive physical activity counseling is *effective* in improving individuals' subjective health, both in the short and in the long term. In order to draw conclusions on *how effective* the interventions were in promoting individuals' health, effect sizes were evaluated. In this respect, short- and long-term changes in trait anxiety and subjective well-being were rather small (i.e. about .20), but however, changes in the physical dimension of well-being were moderate to large. This is partly consistent with the findings of Solberg and colleagues (2012) who found moderate to large effects of Self-Determination Theory-based endurance training on vitality. On the other hand, the effects of functional and strength training on individuals' vitality level were rather small and lasted only in the short term. The slight differences between the effects sizes reported in the respective studies can be explained by the differences with respect to the assessed dimensions of subjective health (i.e. well-being vs. vitality), with respect to the duration of the physical activity programs and the specific the moments of short- and long-term assessment (i.e. after seven weeks and 13 weeks vs. after ten to 12 weeks and one year) or with respect to the format of the provided physical activity programs (i.e. supervised endurance, functional and strength training vs. non-supervised physical activity participation according to participants' preferences).

Despite the demonstrated positive impact of the need-supportive physical activity interventions implemented in Study 1 and Study 2 on participants' subjective health, three remarkable findings should be pointed out. Below, we provide a more detailed discussion on (1) the persistence of the improvements in health, (2) the different findings with respect to the various dimensions of subjective health, and (3) the inconsistencies between the results observed in Study 1 and Study 2 on the one hand and those observed in Study 3 on the other hand.

a) Persistence of the improved levels of health

The effects of the need-supportive programs on participants' subjective health and well-being were less pronounced than those on their physical activity behavior and were not larger than those produced by other physical activity promoting strategies such as referral. Nevertheless, considering the post-intervention and year-round improvements in health and well-being, the Self-Determination Theory-based interventions implemented in Study 1 and Study 2 can be considered as potential health promoting strategies. Moreover, given that previous literature on physical activity promotion produced inconsistent findings with respect to the maintenance of improved health perceptions, the demonstrated year-round effects make these strategies even more valuable (e.g., DiLorenzo et al., 1999; Fox, Stathi, & McKenna, 2007; McAuley et al., 2000; Penninx et al., 2002; Solberg et al., 2012). In addition, the year-round improvements in subjective health that emerged in Study 2 (or the maintenance of satisfactory levels of subjective health in Study 3) are especially remarkable considering that individuals' feelings of health and well-being can be reduced by advanced age as well as by life events that are common in the older adult population (e.g., partner loss, illness) (Beekman, Copeland, & Prince, 1999; Djernes, 2006; McAuley & Rudolph, 1995). Hence, the Self-Determination Theory-grounded physical activity programs implemented in the second intervention study were not limited to the counteraction of age-related declines in psychological health. Even though further subjective health did not further improve after a two-year follow-up period, the counteracting effect was maintained. In order to further improve (older) individuals' subjective health, booster sessions and ongoing follow-ups may be needed.

b) Differences between the various dimensions of subjective health

In line with the assessment of participant's physical activity behavior, the impact of the need-supportive programs was evaluated on different dimensions of their subjective health. The inconsistent findings presented in Study 1 and Study 2 underscored the multidimensional character of individuals' perceived health. In particular, (need-supportive) physical activity coaching yielded improvements in participants' perceptions of (physical) well-being and their feelings of anxiety whereas no improvements emerged with respect to participants' psychological well-being.

The lack of positive changes in psychological well-being is in contrast with the well-established role of physical activity in enhancing individuals' mental health, happiness and feel-good effect (DiLorenzo et al., 1999; Fox, 1999; Opdenacker, 2009). However, this result may be caused by the self-selection recruitment.

In particular, high baseline scores on psychological well-being emerged at baseline, suggesting that participants were already satisfied with their lives. The finding that especially participants with worse initial levels of subjective health improved their well-being underscores our interpretation in terms of a *ceiling effect*. Moreover, the results of the regression analyses pointed out that other factors than physical activity participation may be important to yield satisfied levels of or further improvements in psychological well-being. In this respect, previous research identified the following *determinants of a good quality of life*: demographic characteristics such as being younger and being in a relation, activity-related enjoyment, a positive work climate, group membership, a good physical health, engagement in leisure-time activities and perceived need-support (Everard, 1999; Inder, Lewin, & Kelly, 2012; McAuley et al., 2000; Reis, Sheldon, Gable, Roscoe, & Ryan, 2000; Rejeski & Mihalko, 2001). It should be interesting to study the impact on mental health of a multidimensional strategy including life coaching in addition to physical activity coaching.

c) Inconsistencies between the need-supportive physical activity interventions

Contrary to Study 1 and Study 2, no significant changes in subjective health were observed in the Self-Determination Theory-based physical activity intervention of Study 3. More specifically, improvements in participants' overall health status, their physical well-being and their psychological well-being emerged neither immediately after nor one year after the need-supportive physical activity intervention. As suggested above, the high baseline scores on each of the health dimensions may have contributed to the lack of improvements in those parameters. The high baseline score on physical well-being in particular has probably not only resulted from the self-selection procedure but also from the *recruitment announcement*. More specifically, the announcement of Study 1 referred to the engagement in a physical activity program whereas the announcement of Study 3 referred to a health-related campaign. In this respect, the first intervention study might have approached individuals who were healthy but unsatisfied with their body appearance (referring to physical well-being) whereas the third intervention study might have approached individuals who perceived themselves as healthy both from a physical and psychological perspective. The inconsistent findings on well-being between the respective studies can also be explained by differences with respect to the target population (i.e. adults / adults aged 60 years or older vs. adults aged 55 to 70 years) or the counseling procedures such as the duration of the need-supportive physical activity interventions (i.e. three- to four-month intervention vs. six-week intervention). Nevertheless, even though improvements in subjective health dimensions could not be identified in Study 3, participants' self-rated health, physical well-being and psychological well-being were not reduced after one year. This suggests that need-supportive physical activity counseling may be considered as a potential strategy to, at least, counteract the age-related decline in psychological health.

In conclusion, the intervention effects on subjective health parameters were less pronounced than those on physical activity. Moreover, they were inconsistent between different dimensions of subjective health and between the different Self-Determination Theory-grounded intervention studies. In this respect, the results were in line with previous health-related literature. Nevertheless, the studies presented in this doctoral thesis suggest that a physical activity program that facilitates individuals' psychological needs might be beneficial to enhance individuals' well-being and quality of life, especially among those with an initially lower health perception. In addition, the results indicated that, among the older adult population, need-supportive physical activity counseling may at least be effective in counteracting age-related declines in subjective health, even after a two-year period of time. Finally, the studies demonstrated the potential of more and less time-consuming need-supportive physical activity programs to improve individuals' health and well-being. Therefore, this thesis constitutes a promising step in the development and implementation of cost-effective health promoting strategies in the wider community. However, considering the inconsistent findings, further research on the health impact of Self-Determination Theory-based physical activity promotion is needed.

2.1.2. Discussion of the findings related to Self-Categorization Theory-based physical activity promotion

2.1.2.1. Findings related to physical activity

a) Effectiveness and working mechanisms of socially-oriented physical activity promoting strategies

In the third intervention study, significant and substantial physical activity increases emerged in the social identity condition, both in the short and the long term. More specifically, participants increased their pedometer-based physical activity with approximately 3000 steps a day, which corresponds with an increase of 60% relative to baseline levels. Similar changes were found with respect to participants' self-reported physical activity. These findings demonstrate that *the socially-oriented intervention worked very well*, especially compared to previous pedometer-based psychological interventions among older adults (Tudor-Locke et al., 2011a). Targeting the social level of the self appears thus to be a successful strategy to promote physical activity adoption as well as physical activity maintenance among insufficiently active older adults. Moreover, the considerable increase in the proportion of participants who attained the step-based recommendations points at the potential of this strategy to positively affect public health.

Even though physical activity increases were observed with respect to each of the applied assessment tools, the most remarkable increases were found in aerobic minutes (i.e. almost a fivefold increase at six-week and one-year follow-up relative to baseline levels). Considering that this measurement refers to activities that generate steps at a continuous pace for at least ten minutes, it appears that the social identity-based physical activity promoting strategy particularly influenced participants' engagement in *leisure-time* physical activity rather than their habitual physical activity. Moreover, this result provides support for Ogilvie and colleagues' statement (2007) that walking accounts for much of the performed physical activities among older adults.

Besides studying the effectiveness of social identity-based physical activity promotion, we evaluated the role of integrated regulation on behavioral change. In this respect, integrated regulation was found to mediate the relation between participants' perceived normative support and their physical activity behavior, even though slight inconsistencies were observed between pedometer-based and self-reported physical activity. More specifically, higher levels of perceived normative support for physical activity yielded higher levels of physical activity through higher levels of integrated regulation. This is consistent with the tenets of the Self-Categorization Theory in that this theory explains individuals' behavioral actions as a result of their social identification. The mediating influence of integrated regulation is also consistent with previous research on individuals' motivational profile towards physical activity (e.g., Duncan, Hall, Wilson, & Jenny, 2010), in which integrated regulation was found to positively predict regular physical activity. This result suggests that *viewing physical activity as a part of their identity* can strongly contribute to individuals' physical activity behavior.

b) Comparing individually-tailored and socially-oriented physical activity promotion

Besides studying the effects of social identity-based counseling on individuals' physical activity level, the effects were compared with those produced by personal identity-based counseling. However, contrary to the expectations, no differences in physical activity changes were observed between both types of counseling. This lack of difference in physical activity changes between the interventions is consistent with the observations of Sox and Goodman (2002). More specifically, they stated that, in comparative effectiveness research, differences in treatment effects between various interventions are usually smaller, and therefore less likely to be significant. Nevertheless, this result is in contrast with the Social Identity Approach, which postulates that the (level of) identity that is activated might influence individuals' behavior and cognitions differently (Tajfel & Turner, 1986). Moreover, this result contradicts the results reported by Pearson (2008), who concluded that a physical activity intervention based on the social level of the self is more effective in enhancing the maintenance of physical activity than an intervention targeting the personal level of the self.

The inconsistent findings between the socially-oriented physical activity intervention presented in this thesis and the interventions implemented by Pearson (2008) can be explained by the following five differences between the respective studies:

(1) Participants' characteristics: men and women with a mean age of 62 years vs. women with a mean age of 36 years;
(2) Participants' assignment to the conditions: randomized vs. non-randomized assignment;
(3) The sample sizes
    - Large (n = 169) vs. small (n = 64) sample size;
    - Similar dropout rates vs. non-similar dropout rates in the intervention conditions;

(4) Intensity of the intervention procedure
    - Six (weekly) contacts vs. single contact (at baseline) during which group-based normative support for physical activity was provided;
    - Completion of post-intervention measurements after six weeks vs. after two weeks and completion of long-term follow-up measurements after one year vs. after three months;
(5) Meaning or connotation associated with the applied social identities (socially engaged and independent persons vs. spiritual caring and independent persons);
(6) Underlying theoretical framework
    - Self-Categorization Theory vs. Theory of Planned Behavior in the social identity-based condition;
    - Self-Determination Theory vs. lack of theory in the personal identity-condition.

Contrary to the findings of Pearson (2008), the similar short- and long-term physical activity patterns in the personally- and socially-oriented physical activity intervention observed in Study 3 indicate that targeting individuals' personal self and targeting their social self can be equally effective in promoting physical activity. Consequently, both the Self-Determination Theory and the Self-Categorization Theory appear to be a suitable framework to change individuals' behavior, and in particular their physical activity behavior. Nevertheless, and consistent with previous research on social identification, the results presented in this thesis emphasize the potential of postulating normative support to promote physical activity only among individuals who identify themselves strongly with the targeted social identity.

Furthermore, even though a strategy based on constructs of multiple theoretical frameworks is assumed to yield larger effects than a strategy based on a single framework (Glanz & Bishop, 2010), the physical activity promoting strategy that was grounded in both the Self-Determination and the Self-Categorization Theory did not yield larger physical activity increases than the strategies that were grounded in one of those frameworks. This highlights the *contextuality* of social identification, meaning that individuals can identify themselves with only one (social) identity or group at a time, i.e. the identity that is perceived as most relevant, important and meaningful in the particular context (Tajfel & Turner, 1986). Therefore, it might be that participants of the combined condition were able to categorize themselves at only one level of the self during the contacts as well, and accordingly engaged in physical activity either when their personal identity was activated or when their social identity was activated.

In conclusion, the results reported in this doctoral thesis provide support for the equal (long-term) successfulness of physical activity promotion targeting individuals' personal self during Self-Determination Theory-based coaching, physical activity promotion targeting individuals' social self during Self-Categorization Theory-based coaching and physical activity promotion targeting both individuals' personal and social self. This suggests that a physical activity program can be effective either by underscoring individuals' unique characteristics and supporting their personal needs or by underscoring individuals' membership of a behaviorally relevant reference group and proposing group-based normative support for physical activity. However, considering that postulating group-based physical activity norms involves a non-individualized approach, this counseling strategy entails relatively low costs, and is therefore particularly beneficial to implement in the wider community compared with individually-tailored need-supportive physical activity coaching. Policy makers should therefore support the implementation of physical activity programs that help individuals to believe that physical activity fits their personality, and in particular their group membership. This study constitutes a promising step in the development and (large-scale) implementation of socially-oriented health promoting strategies, but however, the role of social norms on behavioral change should be further examined.

2.1.2.2. Health impact of socially-oriented physical activity promotion

Given that social relations and group membership are considered to positively affect health and well-being (Jetten, Haslam, & Haslam, 2011), this doctoral thesis evaluated the impact of the socially-oriented physical activity interventions on individuals' health perceptions. Results demonstrated enhanced levels of self-rated health after participating in a social identity-based physical activity program, and accordingly indicated that a socially-oriented strategy can be effective in promoting individuals' health. The improvements after a one-year follow-up period are remarkable, especially considering the older adult population in the respective study and the inconsistent findings on the longer-term health impact of physical activity interventions.

At the same time, the social identity-based strategy did not yield changes in physical and psychological well-being. This highlights the *multidimensionality* of subjective health and suggests that emphasizing individuals' group membership particularly influenced their social health (which is considered to be part of individuals' general self-rated health status). Supporting individuals' personal needs, creating an empathetic relationship and emphasizing their unique characteristics appeared to provide an *added value* to the socially-oriented strategy. More specifically, the combined strategy did not only produce improved levels of general self-rated health but also improvements in physical and psychological well-being, at least in this (relatively healthy) sample.

Irrespective of individuals' improvements in health, a higher *degree of identification* with a positively valued group was related to a higher degree of subjective health and well-being. This suggests that group membership does not only contribute to health-related behavior such as physical activity, but

can also be considered as a determinant of satisfactory levels of mental health, self-esteem and cognitive functioning.

In conclusion, the results of the socially-oriented study point out that emphasizing older adults' membership of a positively valued and relevant group can be effective in enhancing their social health, and accordingly their overall self-rated health status. Considering the lack of improved health perceptions in the personally-oriented Self-Determination Theory-based condition, it appears that a social approach is even a more successful health promoting strategy than an individualized approach. However, targeting both individuals' personal self and their social self are demonstrated to be most effective in improving their subjective health. Therefore, in order to positively affect health and well-being at population level, physical activity programs should not only encourage individuals to be physically active but also help them to believe they are a physically active person (i.e. emphasizing their social sense of self and their membership of a meaningful and positively valued group). Even though this thesis constitutes a promising step in the evaluation of the health impact of socially-oriented physical activity counseling, further research is needed to compare the role of relatedness support at the social level and relatedness support at the personal level.

2.2. Methodological strengths and considerations, and suggestions for future research

2.2.1. Design

2.2.1.1. Filling gaps

Each of the three intervention studies contributed to the literature by filling one or more gaps observed in previous research on physical activity promotion. In this respect, specific research questions were formulated, and accordingly specific strengths could be identified with respect to each study.

A first strength of Study 1 constitutes the design. In particular, the first intervention study aimed at examining the effectiveness of need-supportive counseling by conducting a *controlled trial*. Moreover, and consistent with the theoretical focus of the Self-Determination Theory, intervention effects were not only studied immediately after the four-month physical activity program but also in the *long term*, i.e. one year after the program. Finally, instead of examining physical activity and subjective well-being in general, different *intensities* of physical activity and different *dimensions* of subjective well-being were evaluated.

The first intervention study demonstrated increases in participants' physical activity and improvements in their (physical) well-being, and accordingly provided evidence for the year-round effectiveness of need-supportive physical activity counseling among insufficiently active adults. Therefore, the second intervention study aimed at *comparing* the (long-term) effectiveness of a ten-week need-supportive physical activity counseling with less time-consuming physical activity promoting strategies, i.e. a one-contact physical activity referral and a one-contact provision of a partially need-supportive physical activity program. By focusing on both the effectiveness and the *cost-effectiveness* (in terms of counseling intensity) of the physical activity promoting strategies, the implementation potential at community level

could be evaluated. Moreover, the physical activity programs of Study 2 were implemented in an *older adult population* instead of a younger adult population because of the lack of Self-Determination Theory-based research among this population group. Given that ageing may involve feelings of reduced personal control and competence, the Self-Determination Theory seems particularly applicable in the older adult population (Dacey, 2005). Finally, considering the multidimensional and complex character of the main outcome variables, the second intervention assessed both self-reported and *pedometer-based physical activity* and both the positive and *negative components of subjective health* and well-being.

The second intervention study demonstrated the year-round effectiveness of more and less time-consuming need-supportive physical activity counseling procedures among insufficiently active older adults. In the third intervention study, we aimed at comparing the (long-term) effectiveness of individualized physical activity counseling based on the Self-Determination Theory with *group-based* physical activity counseling based on the Self-Categorization Theory, because of the following two reasons:

(1) Group-based physical activity coaching is based on the concept of *social identification*, and therefore assumed to yield behavioral change through the activation of *integrated regulation*. By contrast, need-supportive coaching has up to now mainly focused on facilitating identified regulation. Given that integrated regulation is a more self-determined form of behavioral regulation, group-based physical activity coaching was expected to maintain physical activity increases for a longer period of time than need-supportive coaching;

(2) Group-based physical activity coaching does not involve an individualized approach, and is therefore more beneficial to implement at a *large scale* than individually-tailored need-supportive physical activity coaching.

Furthermore, considering the multidimensionality of physical activity, this study evaluated the intervention effects on (1) daily steps, referring to individuals' *habitual* activities during the day, and (2) daily aerobic minutes, referring to individuals' activities during their *leisure time*.

2.2.1.2. Replication

As suggested above, and in accordance with gaps in the literature on physical activity promotion, each of the intervention studies examined specific research questions. However, the second and the third intervention study were also designed while keeping in mind the findings and conclusions of the previous study/ies. In this respect, the second and the third study were, at least to some extent, replications of the first study. More specifically, the multiple-contact need-supportive *counseling procedure* that was implemented in the intervention condition of Study 1 was similar to one of the counseling procedures that had been implemented in Study 2 and Study 3. The procedure was compared with a no-treatment condition in Study 1 and with less time-consuming physical activity promoting strategies in Study 2 and Study 3.

In addition to the similarities with respect to the counseling procedures, each of the studies presented in this doctoral thesis measured similar outcomes (i.e. physical activity and health) and processes (i.e. self-determined forms of motivation) and used similar *assessment tools* for the outcome and process

measures. For example, physical activity measured by the Godin Leisure-Time Exercise Questionnaire (Godin & Shephard, 1985) was assessed in all three studies, pedometer-based daily steps were assessed in the two intervention studies among older adults, and physical well-being was assessed in the Self-Determination Theory-based study among employees (i.e. Study 1) and in the Self-Categorization Theory-based study among older adults (i.e. Study 3). With respect to the process measures, self-determined (forms of) motivation and perceived need-support of the coach were assessed with the Behavioural Regulation in Exercise Questionnaire (Markland & Tobin, 2004) and the Teacher As Social Context Questionnaire (Belmont, Skinner, Wellborn, & Conner, 1988) in each of the intervention studies.

Furthermore, similar *statistical analyses* were conducted, especially in Study 2 and Study 3. More specifically, in order to study the intervention effects on physical activity and subjective health, linear mixed models were used. This type of analyses is a reliable and statistically-grounded method for handling missing values in a longitudinal design because all observations are included in the analyses (Lane, 2008). Moreover, it allows the researcher to compare changes over time in the outcomes between separate conditions and between different time points. Given that, in Study 2 and Study 3, three intervention conditions were implemented and outcomes were assessed at three moments in time, we considered linear mixed model analyses as superior to repeated measurements analyses in those studies.

Replication of scientific research is important in order to assure the validity and reliability of the findings, to extend the knowledge in a particular field and to enlarge the generalizability of the findings to different population groups and new situations. In this respect, findings with respect to the particular indices of physical activity and subjective health can be compared between and interpreted across the respective studies. Nevertheless, one should be careful in generalizing the results, in particular because of the specific characteristics of the participants' samples (see section 2.2.3.2.).

2.2.1.3. Long-term effectiveness

The studies of this thesis aimed at examining the impact of different physical activity interventions on (older) adults' physical activity adoption and maintenance. More specifically, participants' behavioral changes were not only evaluated immediately after the intervention but also in the long term, i.e. one year after the beginning of the intervention. Similarly, the extent to which the interventions affected participants' health and well-being was examined post-intervention as well as after one year, and even after two years in Study 2.

The evaluation of the year-round effectiveness of the physical activity interventions is especially valuable because most studies on physical activity promotion have only focused on the short-term effectiveness of exercise programs (e.g., Hillsdon et al., 2005; King et al., 1998; Taylor et al., 2004; Van Der Bij et al., 2002). Moreover, among the (limited number of) studies reporting long-term changes in physical activity, only a few showed positive results (Taylor et al., 2004). This suggests that adults who participate in a physical activity program often fall back into their inactive habits after the program or the counselor's support ends (Taylor et al., 2004). The important point to make is that individuals should persist in their

physical activity behavior in order to maintain the health benefits that are associated with physical activity participation, and accordingly to limit health care costs. Programs and counseling strategies that are effective in stimulating individuals to maintain their physically active lifestyle are thus needed, both from an individual perspective (i.e. to attain health benefits) as well as from a societal perspective (i.e. to reduce health care costs).

Considering that supporting individuals' personal needs may be helpful to produce (physical activity) behavior in the long term, the Self-Determination Theory appears to be an appropriate framework to facilitate long-term behavior change (Dacey, 2005; Hillsdon et al., 2005; Stathi, McKenna, & Fox, 2003; Teixeira et al., 2012). In particular, facilitating individuals' personal needs is assumed to yield self-determined forms of behavioral regulation, and consequently maintained behavioral performance. Nevertheless, up to now, only a limited number of longitudinal interventions based on the Self-Determination Theory have evaluated the longer-term impact of a need-supportive program on physical activity participation (Teixeira et al., 2012). Similarly, previous research on social norms, and thus related to integrated regulation, has rarely examined intervention effects on long-term behavioral change.

2.2.1.4. Theoretically-grounded intervention

Previous research has demonstrated the effectiveness of various physical activity promoting strategies. For example, implementing (one of) the following physical activity programs or counseling procedures has been shown to yield enhanced levels of physical activity, physical fitness and health among different population groups: supervised fitness sessions (e.g., King et al., 1998), structured walking programs (e.g., Ogilvie et al., 2007; Pelssers et al., 2013), physical activity referral (e.g., Morgan, 2005), individually-tailored lifestyle coaching (e.g., Dunn et al., 1998; Opdenacker, Boen, Coorevits, & Delecluse, 2008b) and to a lesser extent social identity-based counseling (e.g., Jetten et al., 2011; Pearson, 2008).

In addition to these behavioral and social interventions, informational, environmental and policy approaches have been shown to be effective in increasing physical activity and improving aerobic capacity, both at the individual and at the community level (Kahn et al., 2002; King et al., 1998). For example, previous research has provided evidence for the positive impact of 'point-of-decision' prompts on stair use (Boen, Maurissen, & Opdenacker, 2010; Soler et al., 2010). Moreover, active transportation and physical activity engagement in the neighborhood have been shown to increase when there is a large number of physical activity opportunities, when the convenience of physical activity facilities is improved, when the roads are perceived as safe and when recreational physical activity are easily accessible (Committee on Environmental Health, 2009; Heath et al., 2006; Humpel, Owen, & Leslie, 2002; Owen, Humpel, Leslie, Bauman, & Sallis, 2004).

It appears thus that a variety of strategies are effective in changing individuals' behavior. However, it has been stated that interventions that aim to improve health behavior can be best designed with an understanding of a *theoretical framework* on social and behavioral science (Glanz & Bishop, 2010; Hillsdon et al., 2005). Theoretically-grounded interventions are found to be more effective in facilitating behavioral

change than interventions that lack a theoretical foundation, especially in the long term. Moreover, strategies that are based on a combination of constructs from multiple theories have been found to produce even larger effects than counseling that is based on a single theoretical framework (Glanz & Bishop, 2010). The important point is that an underlying theory can help the researcher to understand why an intervention is (not) effective, and accordingly to identify factors that are needed to develop and implement a successful strategy to change individuals' health behavior. Based on this reasoning, we aimed at designing physical activity promoting strategies that relied on the Self-Determination Theory (Deci & Ryan, 1985) or the Self-Categorization Theory (Turner, 1985). The reasons for applying these theoretical frameworks are explained in detail in the general introduction of this thesis (see Part 1, section 4.5. & Part 1, section 4.6.).

In order to enlarge the effectiveness of the interventions, some of the physical activity promoting strategies were based on multiple strategies to change individuals' behavior or relied on theoretical constructs from different frameworks. For example, the multiple-contact need-supportive counseling in Study 1, Study 2 and Study 3 was combined with the employment of *general behavior change techniques* such as planning, identifying barriers and suggesting prompts and cues (Abraham & Michie, 2008). Each of these techniques has been linked to a theory on behavior change, e.g. Social-Cognitive Theory (Bandura, 1986). Moreover, the physical activity promoting strategy that was implemented in the joined identity condition of Study 3 was grounded in both the Self-Determination Theory and the Self-Categorization Theory. Consequently, most of the interventions described in this thesis involved multiple strategies to change the participants' behavior and / or were grounded in more than one theory. This might have contributed to the large effect sizes observed in each of the studies, especially considering that interventions involving multiple behavior change techniques or based on multiple theories are expected to yield larger physical activity increases than interventions involving only one behavior change strategy or based on none or only one theory (Glanz & Bishop, 2010).

Even though health promoting interventions based on multiple behavior change techniques or on constructs from different theories are assumed to yield larger effects than non-integrated interventions, it is difficult to evaluate this type of interventions. More specifically, a positive intervention effect might result from only one of the applied strategies or theoretical constructs or from an interaction between some of them. In this respect, and as conducted in this thesis, studying the mediating influences of theoretically-grounded mechanisms on the intervention effects can be valuable.

Taken together, the design of the three intervention studies constitutes a particular strength of this doctoral thesis. More specifically, the proposed research questions were consistent with gaps in current physical activity promoting research. Each of the studies embraced replication of counseling procedures, measures and statistical analyses as well as added new elements to previous studies. Moreover, this thesis did not only focus on behavioral adoption but also on behavioral maintenance, and the interventions were grounded in theoretical frameworks. Hence, the presented intervention studies definitely contribute to the literature, irrespective of their results. On the other hand, we acknowledge that the physical activity interventions entailed limitations such as the limited generalizability of the findings to the overall population due to a selection bias and the difficulty to control for confounding factors. Below, we elaborate on those methodological issues.

2.2.2. Measurements and analyses

2.2.2.1. Outcome measures

The main purpose of this doctoral thesis was to study behavioral changes within a physical activity promoting context. In particular, this thesis aimed at examining the extent to which various physical activity promoting strategies yield increases in individuals' physical activity behavior. Nevertheless, each of the studies evaluated the impact of the physical activity interventions on two *different categories of outcome variables*, i.e. outcomes related to physical activity behavior and outcomes related to subjective health and well-being. Focusing on both constructs was meaningful because of the following three reasons:

(1) Previous physical activity promoting research that involved a longitudinal design has usually studied the effects of an intervention on individuals' physical activity behavior. On the other hand, research focusing on health outcomes has typically been cross-sectional. For example, many studies have focused on the associations between individuals' physical activity level and their (self-reported) health status. Studies focusing on the intervention effects of a physical activity promoting strategy on individuals' subjective health are limited, and particularly those with long follow-up periods (Penedo & Dahn, 2005);

(2) Physical activity and health are closely related concepts in that regular physical activity has been demonstrated to prevent individuals from diseases and to improve their health, quality of life, well-being, physical fitness and functional performance (e.g., Biddle & Mutrie, 2008; Penedo & Dahn, 2005). However, even though both constructs are closely related, they differ from each other in that being physically active is a behavior whereas feeling healthy is a perception. In this respect, physical activity behavior can be changed and controlled directly by the individual. By contrast, individuals' (self-reported) health can be influenced by multiple factors, either controllable (e.g., individuals' lifestyle) or uncontrollable (e.g., particular life events). Examining the intervention effects on both individuals' physical activity and their subjective health enabled us to determine the extent to which the implementation of physical

activity promoting programs (indirectly) contributed to improved perceptions of health among the participants;

(3) The studies of this doctoral thesis were grounded in either the Self-Determination Theory or the Self-Categorization Theory. Both frameworks propose assumptions on behavioral change as well as on individuals' health. In particular, they hypothesize that respectively providing need-support and providing normative support facilitate individuals' behavioral performance. In addition, they postulate that respectively need-satisfaction and social identification with a meaningful group positively impact on their cognitive functioning, development and well-being (Jetten et al., 2011; Ryan & Deci, 2000).

In each of the studies, and as suggested by Janz (2006), *different measurement tools* were used to evaluate physical activity and subjective health. This provided a more complete and accurate assessment of both constructs, especially considering their multidimensionality. The applied measurements referred to different aspects of physical activity behavior (e.g., low intensity vs. high intensity, leisure-time vs. habitual) and to different components of subjective well-being (e.g., physical vs. psychological dimension of well-being, feelings that have a positive vs. negative affective nature). The evaluated outcome measures and the applied measurement tools are discussed below.

a) Physical activity

Participants' physical activity behavior was measured by means of pedometer-based and self-report instruments. Physical activity is a complex behavior, from which the assessment is fraught with difficulties. According to Warren et al. (2010), no single method can capture all physical activity subcomponents or domains of interest.

Pedometers are movement sensors recording the total number of steps taken each day. Moreover, by making use of Omron pedometers Walking Style One, the aerobic minutes were displayed as well. Aerobic minutes refer to the period of time that an individual has been physically active at a continuous pace for at least ten minutes and at a minimum rate of 60 steps per minute. Pedometers are inexpensive and relatively easy to use, which facilitates large-scale implementation (Warren et al., 2010). On the other hand, pedometers provide informational and motivational feedback that may stimulate individuals to increase their physical activity (Sugden et al., 2008). This characteristic makes pedometers an effective tool in promoting physical activity, whether or not combined with a theory-based intervention (Sugden et al., 2008). At the same time, these effects create difficulties to distinguish between intervention and measurement effects. Nevertheless, given that pedometer use in the intervention studies lasted for at least five days, the effect of motivational feedback has probably been reduced. Moreover, McMurdo et al. (2010) indicated that the provision of a pedometer yields no additional benefits in physical activity increases compared with a behavior change intervention. In addition, it should be noted that the pedometers were blinded in Study 3, which prevented participants to receive informational feedback. Another limitation of using pedometers to assess physical activity behavior is the inability to determine the type and intensity of

the performed physical activities. More specifically, pedometers do not distinguish between movements that result from climbing stairs, walking or running. Moreover, calculations of participants' daily steps only rely on their activities that generated steps. Water-based activities such as swimming and upper body movements could therefore not be measured by pedometers.

Self-report instruments are the most widely used tool to assess physical activity. They are a cheap and easy way to collect physical activity data from a large number of people in a short time (Warren et al., 2010). Self-report physical activity measurement tools can produce social desirable answers and can involve problems of memory or overestimation. However, in the intervention studies of this thesis, self-reported physical activity was measured by the Godin Leisure-Time Exercise Questionnaire (Godin & Shephard, 1985). This questionnaire is brief and easy comprehensible and asks for the number of times that individuals engaged in mild, moderate and strenuous physical activity for at least 20 minutes in a typical seven-day period during the past month. Moreover, in the intervention studies, the coaches clearly explained this questionnaire and provided a blank schedule on which participants could fill in their weekly physical activity. Consequently, ambiguity and recall bias were probably reduced.

In addition to the abovementioned physical activity measures, participants of Study 2 and Study 3 were asked to complete a physical activity *diary*. More specifically, participants reported the frequency, duration and type of each of the physical activities that they had performed for at least ten minutes during the seven-day period prior to the measurements. By referring to physical activities that lasted for a longer period of time, it is likely that participants mainly wrote down planned and purposeful activities on their diary. For example, participants may have walked around for 20 minutes while doing household chores or they might have performed a 20-minute walk in the forest. However, it is likely that they only indicated the 'planned' walk in the forest on their diary.

Even though both objective and self-report assessment tools involve measurement issues, each method has been shown to be valid and reliable for measuring physical activity (e.g., Crouter, Schneider, Karabulut, & Bassett, 2003; Gionet & Godin, 1989; Godin & Shephard, 1985; Holbrook, Barreira, & Kang, 2009; Kriska & Caspersen, 1997; Sugden et al., 2008; Warren et al., 2010). Moreover, previous research has found significant correlations between the physical activity score based on the Godin Leisure-Time Exercise Questionnaire on the one hand and maximum oxygen consumption (r = .56) and activity monitoring (r = .45) on the other hand (Jacobs, Ainsworth, Hartman, & Leon, 1993; Kriska & Caspersen, 1997). In addition, the use of different measurement tools enabled us to capture multiple components of individuals' physical activity behavior. More specifically, daily steps reflect each of individuals' activities that generate steps during a 24-hour period of time, irrespective of the intensity (e.g., mild, moderate, strenuous), duration (e.g., three minutes, three hours), type (e.g., climbing stairs, dancing, walking, cycling) and purpose (e.g., walking around at home, active transportation, shopping, going for a planned one-hour walk). On the other hand, pedometer-based aerobic minutes and self-reported physical activity measured by the Godin Leisure-Time Exercise Questionnaire only refer to activities that last for a longer and uninterrupted period of time, i.e. at least ten minutes and at least 20 minutes, respectively. Consequently, they are likely to involve

planned, purposeful and leisure-time physical activity such as following a dancing class or going for a walk in the forest.

b) Health and well-being

Participants' subjective health was measured by means of multiple questionnaires. Each of the questionnaires has been shown to be valid and has been applied previously among Flemish (older) adults (e.g., Marcoen, Van Cotthem, Billiet, & Beyers, 2002; Opdenacker, Boen, De Bourdeaudhuij, & Vanden Auweele, 2008c; Pelssers et al., 2013; Raepsaet, Knaepen, Vancampfort, & Probst, 2002; Van der Ploeg, 2000). The use of different self-report instruments enabled us to gain insight in the influence of the physical activity interventions on different dimensions of individuals' perceived health. The following four dimensions of subjective health were studied: (1) participants' perceived health status in general, (2) their physical well-being, (3) their psychological well-being, and (4) their trait anxiety. Hence, the measurements that were applied in the studies of this doctoral thesis referred to indicators of subjective health that have either a positive or negative affective nature (e.g., happiness or stress, respectively) and that refer to either individuals' physical fitness and physical activity behavior or their personality and mental health. Moreover, individuals' perceived health in general probably embraces participants' social health as well. Despite the diversity between the measures, the physical activity promoting strategies have been shown to be successful in improving each of the abovementioned emotions and health perceptions among insufficiently active (older) adults.

All indicators of health and well-being were measured by means of self-report instruments. No objective indicators of health (e.g., physical fitness, level of lipoproteins) were evaluated in the respective studies. The use of self-reports might have led the participants to produce socially desirable answers or to inaccurately interpret some of the questionnaires. Nevertheless, the validity of assessing individuals' health and well-being based upon a cognitive judgment has been supported in the literature (Rejeski & Mihalko, 2001). More specifically, subjective measures of health have been shown to be more strongly related to outcomes such as life satisfaction than objective health indices. Moreover, individuals' physical health status has been identified as an important determinant of their quality of life and their psychological well-being. Similarly, previous research on depression rates among elderly has indicated that physical health problems and functional impairment can produce mental health problems (Djernes, 2006). This suggests that individuals' physical health is, at least to some extent, related to their perceived health status. Finally, and as indicated above, the main focus of this doctoral thesis was to study the impact of various physical activity counseling procedures on individuals' behavioral change. Consequently, studying the intervention effects on objective health parameters was beyond the scope of this thesis.

c) Physical fitness and biological health parameters

Besides studying the intervention effects on individuals' subjective health, it should have been interesting to evaluate the intervention effects on objective health outcomes and individuals' physical

fitness as well. Objective health outcomes refer to biological parameters that influence the risk of cardiovascular and metabolic diseases, e.g. blood pressure, waist circumference and levels of insulin and low density lipoproteins. Physical fitness refers to a set of characteristics that individuals have or achieve in order to be able to perform daily tasks and activities with vigor and alertness, without excessive fatigue and with sufficient energy to enjoy leisure-time pursuits and to meet unexpected difficulties (Caspersen, Powell, & Christenson, 1985).

Individuals' physical activity behavior is positively related to many health parameters and to physical fitness. More specifically, the more individuals engage in physical activity, the greater the health benefits and the higher their level of physical fitness (Kesaniemi et al., 2001; Pate, 1995). However, there is conflicting evidence concerning the precise amount and intensity of physical activity that is needed to optimize individuals' health (Haskell et al., 2007; Pate, 1995). Moreover, in contrast with the day-by-day variability of physical activity, physical fitness remains relatively stable over time (Warren et al., 2010). Therefore, future research should examine (older) individuals' improvements in (objective) health outcomes and physical fitness relative to their (long-term) physical activity increases. More specifically, it could be useful to study the amount, intensity and duration of physical activity that is needed to improve biological health parameters and health-related components of physical fitness such as cardiorespiratory endurance, muscular strength and body composition. Evaluating the effects of physical activity programs on those objective outcome measures should provide more precise information on the impact of different physical activity promoting strategies on (older) adults' functional capacities, and more in general on public health.

In order to study the exact level, intensity and duration of physical activity needed to improve individuals' biological health parameters and physical fitness, sophisticated measurement tools should be used. A relatively innovative method to monitor detailed aspects of individuals' physical (in-) activity pattern throughout the day is the *SenseWear Pro 3 Armband* (Van Hoye, Boen & Lefevre, 2012). This accelerometer-based device provides continuous feedback on individuals' steps taken, their time spent in various intensity zones and their energy expenditure. The SenseWear Armband has been validated in several contexts (Malavolti et al., 2007). However, recent studies have indicated that this measurement tool underestimates energy expenditure, particularly at higher intensity levels of physical activity (Drenowatz & Eisenmann, 2011; Johannsen et al., 2010). Moreover, the SenseWear Armband is expensive and therefore less convenient to use at community level than low-cost pedometers and self-report instruments. Given that the intervention studies of this thesis particularly aimed at facilitating behavioral change and evaluating the large-scale implementation potential of various physical activity promoting strategies, we considered it more appropriate to make use of pedometers and self-report measurement tools than SenseWear Armbands.

2.2.2.2. Mediators

It was valuable to study not only the intervention effects but also the mediating influences on physical activity because it provided insight in the psychological processes leading to or associated with increased physical activity levels. Moreover, it provided (further) support for the theoretical assumptions postulated by the Self-Determination and Self-Categorization Theory. Understanding the (theoretically-grounded) working mechanisms of a physical activity intervention is essential prior to (successfully) implement the intervention in the wider community.

a) Testing theoretical assumptions

In order to test the theoretical assumptions of the applied frameworks, each of the studies evaluated the role of psychological and / or social processes on individuals' behavioral change, both in the short and the long term. More specifically, as proposed by the Self-Determination Theory, the mediating influence of self-determined (forms of) behavioral regulation on the relation between perceived need-support and participants' physical activity behavior was studied. Similarly, and consistent with the assumptions of the Self-Categorization Theory, the mediating influence of integrated regulation on the relation between normative support for physical activity and participants' physical activity behavior was examined. The findings of the studies pointed out the importance of self-determined (i.e. highly qualitative) behavioral regulation to perform physical activity behavior. In this respect, the studies provided evidence for the theoretical assumptions proposed by the Self-Determination and Self-Categorization Theory.

Moreover, the high post-intervention scores on manipulation checks and the between-condition differences with respect to these measures indicate that the theoretically-grounded manipulations were successfully applied in each of the studies. Specifically, in Study 2, a significantly higher score on perceived need-support of the coach was observed in the multiple-contact need-supportive condition than in the referral condition. In Study 3, participants of the social identity and joined identity condition scored (significantly) higher than participants of the personal identity condition with respect to the perceived frequency that their membership of a relevant social group was emphasized during the counseling period. These findings suggest that the physical activity coaches succeeded in applying personally-oriented counseling techniques related to the Self-Determination Theory and socially-oriented counseling techniques related to the Self-Categorization Theory in the respective conditions of Study 2 and Study 3.

b) (Non-) self-determined types of motivation

With respect to the psychological processes contributing to physical activity adoption and maintenance, each of the intervention studies evaluated the mediating influence of autonomous (types of) motivation on individuals' physical activity behavior. As indicated above, and consistent with previous literature and the theoretical assumptions postulated by the Self-Determination and Self-Categorization Theory, the results demonstrated the importance of identified regulation, integrated regulation and intrinsic motivation in the transition from an inactive to a regularly active lifestyle. However, a substantial

proportion of people engage in physical activity because of controlled forms of motivation, and thus because 'they have to' rather than 'they want to' (Ryan, Williams, Patrick, & Deci, 2009; Teixeira et al., 2012). For example, individuals may perform physically active behavior on physician's orders (i.e. external regulation) or to avoid feelings of guilt or failure (i.e. introjected regulation). Therefore, it would have been interesting to examine not only the (mediating) role of autonomous motivation but also the role of motivational regulations that are not volitional on individuals' physical activity behavior.

The studies presented in this doctoral thesis particularly aimed at facilitating the performance of physical activity behavior in the long term. Therefore, we examined the mediating influence of self-determined rather than controlled types of behavioral regulation on physical activity. More specifically, according to the Self-Determination Theory, self-determined, and thus highly qualitative, types of motivation are assumed to produce long-term physical activity engagement. By contrast, controlled types of motivation can sometimes regulate short-term behavior, but however, they are not assumed to yield behavioral maintenance over time (Deci & Ryan, 1985; Teixeira et al., 2012). Moreover, the association between external regulation and physical activity behavior has usually been negative or absent. Concerning introjected regulation, positive associations have been shown with physical activity. However, the strength of the associations appeared to be lower compared to self-determined forms of motivation.

Taken together, the diversity with respect to the applied measurement tools for physical activity and (self-reported) health constitutes a strength of this doctoral thesis, especially because each tool has its limitations. Due to the multidimensionality of physical activity and health, measuring these constructs in a precise and accurate way is a common problem within health promoting research. Sophisticated measurement tools such as the SenseWear Armband would have provided detailed information on the intensity and duration of participants' daily physical activities. However, in the studies of this thesis, low-cost pedometers and self-report measurements were employed, especially because sample sizes were relatively large and because this thesis primarily focused on changing participants' behavior rather than on describing individuals' physical activity pattern. The use of multiple measurement tools allowed us to capture multiple dimensions of physical activity and health. Moreover, each of the studies demonstrated similar effects and trends with respect to the different components of physical activity and health, which provides support for the effectiveness of the applied counseling strategies on increasing different dimensions of individuals' physical activity as well as for the validity and reliability of the applied measurement tools.

Together with the analysis of the mediating role of self-determined motivation on participants' physical activity, the employment of diverse measurement tools for physical activity and health makes this doctoral thesis especially valuable. However, future research should examine the mediating role of controlled forms of motivation on individuals' physical activity and the impact of physical activity interventions on biological rather than on subjective health parameters.

2.2.3. Population and response

2.2.3.1. Targeted population

a) Older adult population

Each of the studies of this thesis targeted a different age group. More specifically, the first intervention study was implemented in an adult population, with a mean age of 41.3 years (min: 23 years; max: 82 years). With respect to the age, the participants' sample of the first intervention can be considered as representative for the Belgian population (Index Mundi, 2013). The second intervention study was implemented in an adult population aged 60 years or older, with a mean age of 69.5 years (min: 59 years; max: 93 years). The third intervention study was implemented in an adult population aged 55 to 70 years, with a mean age of 62.5 years (min: 55 years; max: 72 years). Evaluating need-supportive counseling among populations that vary with respect to their age contributes to the generalizability of the findings.

However, even though the participants' samples of the three studies had a different age range, this thesis primarily targeted the older adult population. This is relevant from a societal point of view because the increasing life expectancy in Western societies yields a continuously growing proportion of older adults (Leon, 2011). Moreover, ageing is associated with declining participation rates in physical activity (Bauman et al., 2009; Lefevre et al., 2002; Philippaerts et al., 2006) and with an increased risk of chronic diseases, disabilities and impaired functioning (Crews & Zavotka, 2006; King et al., 1998; Naughton, Bennett, & Feely, 2006). In addition, research of McNaughton, Crawford, Ball, and Salmon (2012) indicated that transitional life stages such as retirement or partner loss can negatively affect individuals' physical activity behavior. Physical activity promotion among people in the late adulthood and among older adults can thus be considered as a public health priority.

b) Insufficiently active population

Besides targeting the older adult population, each of the studies targeted individuals who could benefit from changing (some of) their health behavior(s), especially with respect to their physical activity level. More specifically, at the start of the interventions, most of the participants were not regularly physically active, neither during their leisure time nor during their daily habitual activities. For example, only 0.6% of the participants of Study 3 attained an average of at least 3000 aerobic steps each day, which corresponds with the performance of 30 minutes of at least moderate intensity physical activity each day, in bouts of ten minutes or more. Similarly, only 25.4% of the participants of Study 2 and 3.6% of the participants of Study 3 took at least 7500 steps a day at baseline, and could thus be classified in the category of 'somewhat active' (Tudor-Locke & Bassett, 2004).

The abovementioned findings indicate that the majority of the participants of the physical activity interventions initially failed to attain the recommended physical activity level for health. Given that almost half of the Flemish and Belgian adults aged between 18 and 75 years do not attain the recommended physical activity level for health, the participants' samples were less physically active than the overall

Flemish or Belgian population (Bauman et al., 2009; Lefevre et al., 2002; Philippaerts et al., 2006; TNS Opinion & Social, 2010; Varo et al., 2003). The proportions of insufficiently active people that are presented in the literature are often based on different physical activity measures and recommendations (e.g., step-based recommendations, recommendations as prescribed by Haskell et al., 2007) and on populations with a different demographic profile (e.g., age, gender). However, each of the previous studies on physical activity rates as well as the studies presented in this thesis draw similar conclusions, i.e. only a minority of the population has a sufficiently active lifestyle in order to attain health benefits.

A large number of participants had changed their lifestyle from inactive or insufficiently active after engagement in (one of) the physical activity programs. For example, whereas almost none of the participants of Study 3 took 7500 steps each day before the intervention, more than 50% of them attained this threshold one year after the intervention. As indicated earlier, changes in physical activity were substantial, and accordingly demonstrate the long-term effectiveness of different physical activity promoting strategies. Moreover, they indicate that health promoting studies based on voluntary participation can be effective in reaching individuals who need to change their unhealthy lifestyle, and in successfully changing their lifestyle.

2.2.3.2. Samples' representativeness

The main limitation of this doctoral thesis is related to the *voluntary participation* in each of the physical activity promoting studies. More specifically, the intervention studies did not involve active recruitment procedures approaching merely individuals with a specific profile to participate in the physical activity program (e.g., those who are not motivated to increase their physical activity level, those who suffer from multiple health conditions etc.). Instead, a physical activity program was offered in the wide community and each individual had the chance to participate in the program, only on condition that they did not attain the physical activity recommendations for health. In particular, in Study 1, participants were university employees who were willing to engage in a four-month physical activity program provided by bachelors in Kinesiology. Recruitment occurred through a personal email and an announcement in a weekly internal newsletter, both entitled 'Searching for a personal physical activity coach?' In Study 2, participants were adults aged 60 years or more who were interested in attending a locally-organized information session on physical activity health benefits and recommendations. Recruitment occurred through advertisements in newspapers, internet-based announcements and pamphlets spread via physicians, pharmacists and socio-cultural organizations. In Study 3, participants were adults aged 55 to 70 years who were selected out of the pool of participants of a preliminary survey. This (web-based) survey was designed to determine important characteristics of older adults in order to optimize health campaigns. Recruitment for participation in the survey occurred through internet-based announcements, advertisements in local newspapers and pamphlets on which a digital link to the survey was displayed.

Even though the majority of the participants did not regularly engage in physical activity at baseline, the voluntary participation, and accordingly the *self-selection recruitment* procedure, that was

applied in each of the studies reduces the representativeness of the samples from different perspectives. Below, we provide an overview of the characteristics of the participants' samples that might result from the voluntary study participation.

a) High motivation

Individuals who were willing to participate in (one of) the physical activity programs were probably those who were highly motivated to engage in health-enhancing behavior. Moreover, considering the physical activity-oriented announcements, it is likely that the volunteers were particularly motivated to improve their health by increasing their physical activity level. This reasoning is supported by the relatively high baseline scores on self-determined forms of motivation to engage in physical activity. In addition, given that, in Study 2 and Study 3, the recruitment partly occurred via socio-cultural organizations, many participants of these physical activity interventions were probably not only members of a socio-cultural organization (e.g., 38.7% in Study 2) but also active and motivated community members in general. In this respect, it is likely that they were regularly engaged in (social) activities organized by the community, related to either exercise or culture. Moreover, the recruitment through socio-cultural organizations might have, to a certain extent, affected the intervention effects of Study 2 and Study 3. In particular, and as suggested in section 2.2.5., participants who were a member of a socio-cultural organization might have engaged in physical activity not only because of the counseling but also because of their social identification and their social participation with other members of the organization.

The rather favorable motivational profile of the participants compared with non-participating insufficiently active adults might have contributed to the *low dropout rates*, immediately after (i.e. < 5%) as well as one year after (i.e. < 22%) the physical activity interventions. However, even though dropout rates were low, results indicated that dropouts were significantly older and attained a smaller number of daily steps than non-dropouts, especially among the older adult population samples and at one-year follow-up measurements. Therefore, future research should develop and implement strategies that improve the long-term compliance of older and initially less physically active individuals (Kelley & Kelley, 2013; Stiggelbout, Hopman-Rock, Tak, Lechner, & van Mechelen, 2005).

Participants' strong motivation to enhance their health might also have contributed to the substantial increases in participants' physical activity level. More specifically, individuals who are initially motivated to increase their physical activity level and to improve their health are probably *'easy to coach'*, meaning that a single stimulus may be sufficient to put them into physically active behavior. By contrast, real 'couch potatoes' or individuals who are initially less motivated to increase their physical activity, and for example do not see the point of being physically active, will probably need counseling that is more intensive and lasts for a longer period of time before they will change their behavior, especially in the long term.

We recognize the fact that participants' initial willingness and strong motivation to engage in physical activity is not representative for the overall population. However, the selection bias with respect to

individuals' motivational profile is a well-known limitation within the domain of physical activity promotion (Foster, Hillsdon, Thorogoods, Kaur, & Wedatilake, 2005). After all, individuals can not be forced to participate in scientific research, even though they should benefit from their participation.

b) Satisfactory health status

The voluntary character of the study participation might not only have resulted in highly motivated samples but also in relatively healthy samples. In particular, participants were community-dwelling (older) adults who did not suffer from chronic diseases, disabilities or functional limitations that prevented them from being physically active at a regular basis. In this respect, it appeared that participants were in a relatively good *physical health*.

In addition, the high baseline scores on self-reported well-being suggest that participants had a satisfactory *subjective health* as well. In particular, more than two thirds of the participants of Study 2 and Study 3 indicated that they were, at least often, satisfied with their body appearance and their life. Nevertheless, the results showed that participants scored especially high on the psychological dimension of well-being whereas the baseline scores on the physical dimension of well-being were rather moderate. These findings suggest that individuals who volunteered to participate in one of the physical activity interventions were happy with who they are but less happy with how they looked like. In this respect, they might have been willing to participate in a physical activity program in order to change their lifestyle from inactive to regularly active, and in this way improve their satisfaction with their body appearance.

c) Demographic profile

The voluntary participation in the intervention studies and the applied (non-active) recruitment procedures might have yielded a selection bias with respect to participants' demographic profile. More specifically, and as discussed below, the majority of the participants were women and were highly educated.

i. Gender

Descriptive analyses indicated that respectively 51.6%, 33.3% and 39.1% of the participants of Study 1, Study 2 and Study 3 were men. However, according to the Institute of Statistics Belgium, 49.3% of the population in Flanders is male (Federale Overheidsdienst Economie, 2011). Among the Flemish population aged 60 years or more, the proportion of men is reduced to 44.8% (Federale Overheidsdienst Economie, 2011). Compared to the overall Flemish population, men were thus somewhat overrepresented in the first study and substantially underrepresented in the two other studies.

The slight overrepresentation of male participants in Study 1 is can be attributed to the gender distribution of the employees at the KU Leuven, from which the participants were recruited (KU Leuven, 2009). In the first intervention study, the response rate of men on the announcement can thus be considered as similar to the response rate of women.

The underrepresentation of men in Study 2 and Study 3 is consistent with a review of Conn, Minor, Burks, Rantz, and Pomeroy (2003) on physical activity promotion among ageing adults. More specifically, they stated that women are generally well represented compared to men in physical activity interventions in the older adult population. However, it remains an open question whether or not men were underrepresented in the respective studies because of the applied recruitment procedures (i.e. through local media, socio-cultural organizations and pamphlets via physicians) or because they are generally less interested in participating in physical activity interventions (for example, and as suggested above, because they are more satisfied with their body than women). In addition, the age-related change in gender distribution at population level may also have contributed to the underrepresentation of men in Study 2.

ii. Education

It appears that the applied recruitment procedures and the voluntary participation in the studies have resulted in participants' samples with a rather high educational level. More specifically, due to the recruitment in a university setting, 69.9% of the participants of Study 1 were (emeritus) professor or research assistant. In Study 3, the average number of educational years was 13.98 ± 2.33, with respectively 9.5%, 25.4% and 65.1% of the participants having a primary education (i.e. at least nine years of education), a secondary education (i.e. at least 12 years of education) and a high education (i.e. 15 or more years of education and having obtained a university or college degree). The relatively high education of the sample in Study 3 might not only originate from the voluntary character of study participation but also from the format of the preliminary survey. More specifically, the survey, from which participants of the physical activity intervention were recruited, was web-based. According to previous research (Silver, 2013; Van Aerschot & Rodousakis, 2008), a high socio-economic status, and more specifically a high education, is still one of the most significant determinants of Internet use, in particular among the older adult population.

The educational level of the participants of Study 1 and Study 3 is largely above the educational level of the Flemish population. More specifically, 31.4%, 37.3% and 31.3% of the Flemish population has obtained a primary, a secondary and a high education, respectively (Federale Overheidsdienst Economie, 2012a). Moreover, the educational level of participants of Study 3 exceeds the educational level of participants of Study 2 (i.e. 12.08 ± 2.76 years, with respectively 31.0%, 36.4% and 32.6% of the participants having a primary, a secondary and a high education) and the educational level reported in other studies on physical activity promotion among Flemish older adults (Opdenacker et al., 2008b; Pelssers et al., 2013). The difference in education between participants of Study 1 and Study 3 on the one hand and participants of Study 2 on the other hand might not only have resulted from the different setting out of which participants were recruited (i.e. university vs. local community) and the different format of the recruitment announcement (i.e. web-based vs. via pamphlet) but also from the difference in participants' age category (i.e. adults up to 70 years vs. adults aged 60 years or older) (OECD, 2013b). More specifically, a smaller proportion of older adults compared to younger adults are highly educated.

Participants' high education might be consistent with their strong motivation to participate in a physical activity intervention. In particular, previous research has indicated that individuals' educational level is strongly related to their engagement in sport and exercise or at least their willingness to participate in physical activity (TNS Opinion & Social, 2010).

Individuals' educational level has been used frequently as an indicator of their *socio-economic status* (Braveman et al., 2005; Oakes & Rossi, 2003; Robert & House, 1996). In this respect, correlations between individuals' academic achievement and their socio-economic status have been shown to jump to .73 (Sirin, 2005; White, 1982). Even though socio-economic status is a complex phenomenon that is best predicted by multiple determinants such as individuals' financial situation, occupational status or educational level, education is the most constant measure of social status over the course of individuals' lifetime (Braveman et al., 2005; Kwok & Yankaskas, 2001). Therefore, and because participants were not asked to report their financial situation, we believe it is appropriate to consider participants' education as a valuable univariate indicator of their socio-economic background.

2.2.3.3. Approaching the 'hard to reach'

As suggested above, and even though participants were individuals who would benefit from changing their lifestyle, the voluntary participation in the health promoting studies may have produced a selection bias, at least to some extent. Therefore, the *generalizability* of the findings may have been reduced to individuals who are less motivated to increase their physical activity level, are in poorer health and have less education. Below, we provide some strategies that might be helpful to increase physical activity participation at population level, and in particular to reach the 'hard to reach'.

a) Changing the physical environment

The high level of physical inactivity, and the unhealthy lifestyle in general, among a large proportion of the population requires a policy response. More specifically, there is a need for health promoting actions within the broader socio-ecological domain. In this respect, and in addition to the lifestyle approaches that aim to directly influence individuals' physical activity behavior, changing the physical environment have been demonstrated to be a helpful strategy to facilitate health behavior at community level. For example, creating accessible recreational facilities have been shown to stimulate physical activity engagement in the neighborhood, building safe bicycle and footpaths have been demonstrated to stimulate active transportation and providing prompts to climb the stairs instead of using the elevator have been shown to stimulate individuals to incorporate physical activity in their daily routines (e.g., Soler et al., 2010; Van Cauwenberg et al., 2012). Developing structural changes can make healthy choices easy choices (Östlin, Eckermann, Mishra, Nkowane, & Wallstam, 2006; Sacks, Swinburn & Lawrence, 2009).

b) Collaboration with general practitioners

In order to make those 'hard to reach' individuals participate in a health-oriented and in particular a physical activity program, active recruitment procedures that successfully approach the entire (and thus also the less motivated, less healthy and less educated) population should be applied. In this respect, a cooperation between physical activity counselors and general practitioners may be helpful. General practitioners are generally perceived as trustworthy (Naidoo & Wills, 2000). Moreover, they are in contact with their patients one or more times a year, especially with those who suffer from medical conditions and who may thus benefit even more from physical activity participation than healthy individuals. In this respect, Kallings, Leijon, Hellénius, and Ståhle (2008) found that physical activity on prescription produced physical activity increases among patients who needed physical activity preventively or for the treatment of a disease. They concluded that physical activity on prescription may be an effective strategy in a health care setting to promote a physically active lifestyle.

c) Multidisciplinary approach

The studies of this thesis particularly aimed at helping individuals to attain the physical activity recommendations for health. However, focusing on the promotion of other health behaviors than merely physical activity can stimulate a more diverse population to participate in a health promoting program. For example, it might be that individuals are unable to participate in physical activity because of their old age or because of their heavy weight, and accordingly are unlikely to participate in a physical activity program. In this respect, other or at least additional health-enhancing strategies should be implemented to help these individuals to obtain a better health. The 'Beweegkuur', which constitutes a multidisciplinary counseling program in the Netherlands, has been demonstrated to be effective in working towards a healthier and more active population (Beweegkuur, 2013).

i. Reducing sedentary behavior

Considering the health-oriented character of the studies, it should have been interesting to focus not only on increasing individuals' physical activity but also on reducing their sedentary behavior. Sedentary behavior refers to the performance of activities that do not increase individuals' energy expenditure above the resting level such as sleeping and television viewing (Pate, O'Neill, & Lobelo, 2008). Sedentary behavior has been identified as an important determinant of individuals' health, independent of their physical activity level (Hamilton, Healy, Dunstan, Zderic, & Owen, 2008). More specifically, a shorter duration of sedentary behavior and an interruption of prolonged bouts of sitting have been shown to positively affect individuals' cardiovascular and metabolic health (e.g., Dunstan et al., 2005; Hamilton et al., 2008; Healy et al., 2008; Proper, Singh, van Mechelen, & Chin A Paw, 2011). Given that being physically active and being sedentary are two behaviors that may coexist, health promoting interventions should stimulate individuals to engage in physical activity behavior as well as to minimize their sitting time (Owen, Leslie, Salmon, & Fotheringham, 2000).

At this time, interventions aiming at reducing individuals' sedentary behavior are limited, partly because of the difficulties associated with the assessment of this behavior (Atkin et al., 2012). Nevertheless, this strategy might be especially relevant in the older adult population, given that a large number of older adults suffer from chronic diseases, disabilities and muscle weakness (Crews & Zavotka, 2006; Doherty, 2003; Hoffman, Rice, & Sung, 1996; King et al., 1998; Naughton et al., 2006). Chronic medical conditions can result in reduced physical fitness and functional limitations, and accordingly prevent individuals to attain the minimum recommended physical activity level for health. Those individuals should thus not only be encouraged to engage in physical activity according to their abilities but also, and even more importantly, to avoid sedentary behavior (Nelson et al., 2007). For example, they should be stimulated to interrupt their sitting time by standing up regularly while reading, waiting or watching television.

Due to the voluntary participation in the interventions of this thesis, the participants' samples consisted of relatively healthy (older) adults who did not have functional limitations. Hence, the health promoting interventions especially focused on increasing participants' physical activity behavior rather than on decreasing their sedentary behavior. Moreover, despite the beneficial effect of interrupting periods of sitting on individuals' health, Scheers (2012) indicated that interventions focusing merely on discouraging sedentary behavior are insufficient to prevent individuals from the metabolic syndrome. In addition, interruptions of sedentary behavior generally involve mild intensity physical activities and are relatively short in duration (Healy et al., 2008). Lower intensity physical activities that last for a short period of time have been found to produce less aerobic, metabolic and cardioprotective benefits than higher intensity physical activities that last for ten minutes or more (Scheers, 2012; Strath, Holleman, Ronis, Swarts, & Richardson, 2008; Swain & Franklin, 2006; Williams, 1998). Therefore, it should be a priority of health-oriented studies to promote (higher intensity) physical activity, even though reduced sitting time can also contribute to improved levels of health. Even (older) adults with lower functional capacities should not only be encouraged to interrupt their sitting time but also to engage in physical activity, albeit according to their abilities and with gradually increasing duration and intensity.

ii. Stimulating healthy eating

In addition to supporting individuals to engage in physical activity and to reduce their sitting time, health promoting interventions should stimulate individuals to eat healthy. Healthy eating, moderating alcohol consumption and heaving a body mass index below 25 are considered as key lifestyle behaviors, besides engaging in regular physical activity and eliminating tobacco exposure (Patrick & Williams, 2012). Not complying with (one of) those behaviors yields higher risks of cardiovascular, metabolic and psychological diseases (Lichtenstein et al., 2006; Patrick & Williams, 2012). In this respect, it has been suggested that three fourths of all health care costs are attributable to chronic diseases that result from unhealthy behaviors such as a poor diet, a lack of physical activity and tobacco use (Patrick & Williams, 2012; Tudor-Locke & Bassett, 2004).

Consequently, future research should study the effectiveness and implementation potential of a multidisciplinary lifestyle approach, i.e. a health promoting program stimulating the adoption and maintenance of different health behaviors. However, in this thesis, and as indicated above, the purpose was not only to evaluate the implementation potential of health promoting strategies at community level (i.e. practical discourses) but also to examine whether the use of various theoretical frameworks facilitate individuals' behavioral change (i.e. scientific discourses). In order to study the precise impact of a theoretically-grounded counseling on individuals' behavior and to avoid interactions between different health behaviors, we decided to put emphasis on only one health behavior, i.e. physical activity. Nevertheless, the applied techniques and counseling methods might be helpful to facilitate behavioral change within other health-related domains such as healthy eating or smoking cessation.

Taken together, the majority of the participants of the physical activity interventions presented in this thesis could definitely benefit from increasing their physical activity level. More specifically, many of them were older adults who were insufficiently active. Nevertheless, the voluntary participation may have produced a selection bias with respect to participants' motivation to increase their physical activity, their general health status and their educational level. The lack of representativeness of the studies' samples hampers the potential to generalize the findings to the overall population, and accordingly reduces the external validity. This is a common problem within the literature on health promotion, particularly because participation in a health-enhancing study does rely on voluntarism. Future research should make use of active recruitment procedures that are not based on voluntarism in order to evaluate the (long-term) effectiveness of physical activity programs in a sample that is representative for the population as a whole or for specific population groups (e.g., individuals suffering from chronic diseases, minority groups, individuals who belong to the oldest old, individuals with a low socio-economic status etc.).

On the other hand, the similar results of the different need-supportive interventions on participants' physical activity behavior indicate that this type of physical activity counseling is effective in younger as well as in older adults. This finding provides support for the generalizability of Self-Determination Theory-based physical activity promotion to different age groups.

2.2.4. Implementation potential

The intervention studies described in this doctoral thesis are situated within the domain of health promotion, and in particular physical activity promotion. Consequently, the purpose of the studies was not only to *provide scientific evidence* but also to explore the potential to *translate the research into the wider community*. This twofold purpose of the studies has led us to apply the Self-Determination Theory as the primarily underlying framework for the physical activity interventions. More specifically, this theory is consistent with clinical guidelines and tenets of practice (e.g., motivational interviewing), and can therefore be considered as appropriate for both scientific research and practical discourses (Patrick & Williams, 2012).

2.2.4.1. Cost-effectiveness

In order to evaluate the implementation potential of the different physical activity promoting strategies, we examined their effectiveness (i.e. effect sizes) as well as explored their cost-effectiveness. Costs were expressed in terms of *counseling intensity*, i.e. the number and duration of the contact moments between coach and client, individualized versus group-based contact, type of contact mode, preparation of the counseling etc. By contrast, no information was provided on the costs of the interventions in terms of finances. Specifically, the second study compared the effectiveness of a single-contact and a multiple-contact need-supportive program. Moreover, the third intervention study aimed at comparing the effectiveness of individually-tailored coaching with non-personalized group-based coaching. The one-contact procedure and the social identity-based counseling were less time-consuming than the multiple-contact need-supportive counseling, and therefore particularly beneficial to translate into the wider community.

Even though some of the counseling strategies involved multiple individually-tailored contacts between coach and participant, and hence entailed relatively high costs (in terms of counseling intensity), the large-scale implementation potential of each of the counseling procedures was enlarged by the following three strategies:

(1) The *duration* of the counseling period as well as the *number of contacts* during this period was limited in each of the physical activity promoting strategies. For example, the need-supportive counseling implemented in Study 1 consisted of only five individual contact moments during a four-month intervention period;

(2) Different *types of contact* were applied to facilitate behavioral change, except for the first contact which occurred face-to-face in each of the studies. Previous research has demonstrated the equal effectiveness of face-to-face contact, computer-tailored contact and contact by phone in improving behavioral health outcomes (Fortier et al., 2007; Opdenacker & Boen, 2008a; Portnoy, Scott-Sheldon, Johnson, & Carey, 2008). In this respect, participants of Study 1 and Study 2 were supported through face-to-face contacts, booster phone calls or email conversations, in accordance with their preferences and needs;

(3) Some individuals might need to participate in physical activity sessions together with their coach, at least in the beginning of the program. Nevertheless, participants of the present studies performed their physical activities neither in the company nor under the *supervision* of their physical activity coach. Instead, they were taught several techniques in order to be able to continue their physical activity participation after the intervention.

Developing a physical activity promoting strategy that is both effective and cost-effective is important to obtain a *public health impact*. More specifically, a strategy that is effective in increasing individuals' physical activity level but, at the same time, too expensive to implement at community level can only help a small proportion of the population to change their lifestyle, and accordingly will be insufficient

to reduce health care costs at the societal level. In this respect, previous research has compared the costs (in terms of finances) associated with a lifestyle physical activity intervention involving a limited number of contacts and those associated with a structured fitness intervention involving continuous supervision (Opdenacker, 2009; Sevick et al., 2000). Even though both programs were found to be equally effective in increasing individuals' physical activity level and physical fitness, the supervised fitness intervention was four times more expensive than the lifestyle intervention per participant per month, and therefore less appropriate to implement at large scale.

The importance to implement a cost-effective physical activity promoting strategy in the wider community has led us to conduct *comparative effectiveness studies* rather than controlled trials. Comparative effectiveness research is especially valuable within the domain of health and physical activity promotion because it provides clinicians and policy makers to make informed decisions prior to translating research into practice (Sox & Goodman, 2012). On the other hand, and as indicated in the section below, the use of a comparative effectiveness design instead of a controlled design may reduce the internal validity of the study.

2.2.4.2. Comparative effectiveness research

In order to draw strong conclusions on the precise impact of a physical activity promoting strategy relative to participation and measurement effects, a *controlled trial* should be implemented. In this respect, and as described previously, the first intervention study examined the effectiveness of need-supportive physical activity counseling by comparing an intervention and a control condition.

The inclusion of a no-treatment condition allowed us to control for the influence of measurement and participation effects and provided evidence for the positive influence of the need-supportive intervention on individuals' physical activity behavior and their subjective well-being. However, at the same time, the inclusion of the control condition entailed procedural issues in that participants were not randomized between the intervention and control condition. More specifically, the response on the recruitment announcement was unexpectedly large. Due to ethical, educational and social reasons, the 'first come - first served' principle was applied, meaning that only first responders were allowed to participate in the intervention. The remaining volunteers were given priority to participate in the physical activity program during the next year and were asked to complete the measurements during the current intervention period (i.e. being included in the waiting-list control condition).

One should argue that the non-randomized assignment of the participants to the intervention and control condition involves a selection bias and results in confounding between both conditions. However, no significant baseline differences emerged between the intervention condition (i.e. first responders) and control condition (i.e. 'late' responders) with respect to demographic variables, well-being, motivation to engage in physical activity and low to moderate intensity physical activity. Therefore, we consider it reasonable to interpret the improvements in physical activity behavior and subjective well-being in the intervention condition as resulting from the physical activity coaching rather than from a potential selection

bias. Unfortunately, we do not have information on the motivational profile of the initial volunteers who were not included in the intervention or control condition. However, 94% of all the volunteers responded within 24 hours after the announcement was made. Therefore, we believe that the motivation to engage in physical activity among the volunteers who were included in the control condition was similar to the motivation among the volunteers who were not included in the control condition.

Contrary to the first study, no control condition was included in the second or third intervention study. Instead, *comparative effectiveness studies* were conducted, particularly because these studies aimed at evaluating and comparing the related costs (in terms of counseling intensity), and accordingly the implementation potential of various physical activity promoting strategies (Sox & Goodman, 2012). First of all, this type of research aims at examining the effectiveness of a physical activity promoting strategy rather than its efficacy. Effectiveness trials determine whether an intervention produces the intended effect under 'real-world' conditions and works in people to whom it has been offered. By contrast, efficacy trials determine whether an intervention produces the intended effect under ideal circumstances and works in people who receive it (Courneya, 2010). Consistent with the definition of an effectiveness study, this thesis aimed at testing behavioral change interventions that are deemed at least potentially feasible to put into practice rather than studying effects in a controlled laboratory.

Furthermore, comparative effectiveness research aims at evaluating and comparing health outcomes and the clinical effectiveness, risks and benefits of two or more (medical) treatments or services (Sox & Goodman, 2012). An additional purpose of this type of research is to assist consumers, clinicians and policy makers to make informed decisions that will improve health (care) at both the individual and population level (Institute of Medicine, 2009; Sox & Goodman, 2012). By focusing on both the effectiveness and the cost-effectiveness of an intervention, comparative research is especially valuable within the domain of health and physical activity promotion (Sox & Goodman, 2012; King et al., 1998).

The following two reasons have led us to conduct a comparative research study rather than a controlled trial in Study 2 and Study 3:

(1) Considering their voluntary participation, all participants were strongly motivated to increase their physical activity. Therefore, and in accordance with Courneya's conclusion (2010), we considered it *unethical* to assign them to a no-treatment condition;

(2) The aim of these intervention studies was not only to provide scientific evidence for the effectiveness of theoretically-grounded physical activity interventions but also to explore and compare the *large-scale implementation potential* of different physical activity promoting strategies. Specifically, the second intervention study aimed at comparing the effectiveness of a minimal intervention condition, a single contact need-supportive counseling procedure and a more time-consuming need-supportive coaching. The third intervention study aimed at comparing the effectiveness of a multiple-contact individually-tailored physical activity coaching and a socially-oriented physical activity coaching. Given that the planning and preparation of the socially-oriented physical activity counseling took place at the level of the

condition rather than at the level of the participants, this strategy was considered as less time-consuming than the individualized counseling.

Despite the benefits of comparative effectiveness research and its importance to develop cost-effective health-enhancing programs, the results of a comparative effectiveness study may sacrifice internal *validity* for external validity (Sox & Goodman, 2012). Internal validity refers to how well an experiment is conducted, and in particular to the degree to which the intervention effects are caused by the treatment or by confounding factors. The higher the control for confounding influences (e.g., in a laboratory experiment), the higher the internal validity. As suggested above, efficacy rather than effectiveness studies aim at optimizing their internal validity. On the other hand, external validity refers to how well procedures and findings from one setting can be applied in and generalized to another setting or population. The better an intervention can be translated from the laboratory to the community, the higher the external validity of the study.

Given that the comparative effectiveness research that was conducted in Study 2 and Study 3 embraced interventions that were tested in the community (i.e. 'real-world' situation), participants' behavior might have been influenced not only by the physical activity counseling but also by uncontrollable environmental factors. In this respect, the intervention effects might have been biased to some extent and the internal validity might have been slightly reduced. On the other hand, the increased physical activity levels were maintained after a one-year follow-up period, similar effects on physical activity were found in both studies and results of the mediation analyses provided evidence for the role of autonomous motivation in the adoption and maintenance of physical activity behavior. Therefore, it appears that the need-supportive or social identity-based counseling implemented in Study 2 and Study 3 substantially influenced participants' physical activity pattern, irrespective of confounding factors or their study participation.

The inclusion of an additional intervention condition instead of a no-treatment condition makes it particularly difficult to control for participation and measurement effects. Consequently, the magnitude of the intervention effects observed in Study 2 and Study 3 might have been somewhat overestimated. In order to be informed on the precise impact of a physical activity promoting strategy on individuals' physical activity behavior and well-being, future research should not only compare the effects of different physical activity promoting strategies with each other but also with a strategy that provides no counseling, delayed counseling or counseling that is not related to physical activity or health.

On the other hand, assigning individuals who are initially motivated to increase their physical activity to a no-treatment condition may not only be unethical but can also produce inaccurate results because of the following two reasons:

(1) A *Hawthorne effect* may occur, meaning that individuals change their behavior merely because of their participation in the study. Participants of a no-treatment condition may be likely to increase their physical activity level, even without receiving physical activity counseling;

(2) *Contamination* between the intervention and control condition may occur, meaning that the behavior of participants is affected by the behavior of other participants of the study. More specifically, individuals of the no-treatment condition who are acquainted with individuals of the intervention condition may be likely to participate in the same physical activities, whether or not together.

Another aspect that has led us to abstain from designing a (waiting-list) controlled trial constitutes the enormous costs and the abundance of time that are associated with the implementation of health-enhancing interventions. For example, Opdenacker (2009) estimated the costs of a three-month lifestyle intervention with regular face-to-face contact at 35 euro per person per month. Including a waiting-list control condition in each of the intervention studies of this thesis should have been unrealistic both from an economic as well as from an organizational perspective.

Taken together, the purpose of the studies presented in this doctoral thesis was to provide scientific evidence for theoretically-grounded physical activity promotion as well as to explore the implementation potential of the physical activity programs. In this respect, the studies evaluated both the effectiveness and the cost-effectiveness (in terms of counseling intensity) of the interventions. It is valuable to take into account the counseling intensity when developing a physical activity promoting strategy, especially considering the need to promote health at population level. On the other hand, the aim to evaluate the cost-effectiveness and accordingly the large-scale implementation potential of the physical activity promoting strategies has led us to compare different physical activity interventions rather than including a control condition. We acknowledge that this type of research may have reduced the internal validity of the respective studies. Therefore, future research should attempt to control for confounding factors by comparing time-consuming physical activity counseling not only with less time-consuming physical activity counseling but also with counseling that is not related to physical activity (e.g., counseling related to relaxation or brain training). The important point is to strike a balance between the theoretical foundation and the practical implications when designing a physical activity promoting program.

2.2.5. Group membership

2.2.5.1. Social identity (mis-) match

Besides providing evidence for the effectiveness of individually-tailored need-supportive physical activity counseling, this doctoral thesis demonstrated the positive impact of socially-oriented counseling on individuals' physical activity level and, albeit to a lesser extent, their subjective well-being. More specifically, the findings of the third intervention study indicated that postulating physically active behavior as normative for a relevant social identity yields substantial increases in physical activity among participants who strongly identified themselves with the particular identity. This result was consistent with previous literature on social identification in which positive associations between identity-based norms towards

physical activity and physical activity attitudes, intentions and behaviors were found (e.g., Pearson, 2008; Renger, Steinfelt & Lazarus, 2002; Terry & Hogg, 1996).

As suggested above, proposing social identity-based normative support for a particular behavior can yield behavioral adoption and maintenance, but however, only when the individual strongly identifies him / herself with the targeted social identity. The level of the self at which and the group with which one categorizes him / herself does vary according to the context (Haslam, 2004; Tajfel & Turner, 1979). More specifically, individuals identify themselves with the (social) identity or group that is perceived as most relevant, important and meaningful in the particular context (Hogg, 2006; Jetten et al., 2011). For example, a man can categorize himself as a runner during his running session but as a husband when he is enjoying time with his wife. It is likely that this man's cognitions and behaviors will be affected by his identification in each of the abovementioned situations.

Given the contextuality of individuals' social identification, it should be interesting to study the impact of social identity-based (physical activity) counseling on individuals' behavior when they do not (strongly) identify themselves with the particular identity. In this respect, a *mismatch* between the proposed identity and individuals' identification would occur. Specifically, it should be interesting to examine whether, in this situation, individuals should simply not respond to the identity-based counseling or should perform a behavior that is in contrast with the proposed behavior. The latter should be in accordance with the study of Oyserman, Fryberg, and Yoder (2007), who demonstrated that members of ethnic minority groups reacted against messages on healthy eating from White middle-class populations because they viewed healthy behavior as non-normative for their own social category. Social identification can thus put individuals into health promoting behavior but also into health impeding behavior. In addition, individuals might also respond to such a mismatch by performing the proposed (i.e. healthy) behavior, but however, by activating a controlled rather than an autonomous type of behavioral regulation.

The following example illustrates these hypotheses: "During a consultation, the general practitioner aims at encouraging his / her 58-year old patient to engage in walking by saying 'Walking fits the identity of older adults and running fits the identity of younger adults.' The patient is a man who is currently not engaged in physical activity. Moreover, the man does not identify himself with older adults." The question remains whether this man would not respond to the doctor's advice and continue his physically inactive lifestyle, or would react against the advice and go for a run instead of going for a walk (which might entail health risks), or would go for a walk but because it is recommended by the general practitioner (i.e. external regulation) rather than because he identifies himself with older persons / walkers (integrated regulation).

Furthermore, the social identities (e.g., socially engaged persons) that were applied in the socially-oriented intervention study had a high group formation potential. This means that individuals who identified themselves strongly with the group perceived themselves as similar to those who share the particular self-characteristic but as different from those who do not share the particular characteristic. Future research should focus on the effectiveness of providing identity-based normative support for a

(health) behavior when the particular social identity has a *low group formation potential*. This means that individuals who identify themselves strongly with the group perceive themselves not or to a lesser extent as similar to those who share the particular self-characteristic. Examples of social identities that might involve a low(er) group formation potential are role-based identities (e.g., parent) and identities based on demographic characteristics (e.g., related to gender, age, ethnicity). Contrary to personality-based characteristics, role-based and demographic self-characteristics involve objective features rather than a subjective connotation. Therefore, it might be easier, and accordingly less time-consuming, to implement socially-oriented physical activity counseling based on role-based or demographic self-characteristics than socially-oriented physical activity counseling based on a personality-based self-characteristic.

2.2.5.2. Social participation

As indicated above, postulating physical activity behavior as normative for a group can increase physical activity engagement among individuals who perceive themselves as a member of this group. Group membership at the cognitive level can thus be effective in increasing individuals' physical activity. In addition to social identification, physical interaction can positively affect individuals' physical activity behavior. In this respect, previous research has demonstrated the potential of group-based exercise sessions to promote physical activity (e.g., King et al., 1998; Pelssers et al., 2013).

Social identification and social participation can take place independently of each other (Hogg, 2006). For example, an individual who is playing with his / her grandchild can define him / herself in terms of an older person, even though he / she is not in the company of other older adults. A person (alone) can feel and act as a group member, as long as he / she shares a social identity that is defined by the (larger) group. On the other hand, two individuals can be in the company of each other, even though they do not identify themselves with the same identity at the particular moment. Therefore, it should be interesting to examine whether social participation adds value to social identification within the domain of physical activity promotion. More specifically, future research should compare the effectiveness of a strategy that stimulates individuals to engage in physical activity by activating a relevant social identity (referring to social identification) with the effectiveness of a strategy that stimulates individuals to engage in physical activity in the company of other individuals who identify themselves with the particular identity (referring to both social participation and social identification).

Taken together, the studies presented in this doctoral thesis contribute to the literature on physical activity promotion by studying the effectiveness of both individually-tailored and socially-oriented physical activity promoting strategies. Evaluating social identity-based counseling is especially valuable because this type of counseling is less time-consuming than personalized counseling, and therefore especially beneficial to implement in the wider community. However, future research should examine whether physical interaction provides an added value to social identification within the domain of physical activity promotion.

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Wilson, D. K., Evans, A. E., Williams, J., Mixon, G., Sirard, J. R., & Pate, R. (2005). A preliminary test of a student-centered intervention on increasing physical activity in underserved adolescents. *Annals of Behavioral Medicine*, 30(2), 119-124.

Wilson, P. M., Rodgers, W. M., Blanchard, C. M., & Gessell, J. (2003). The relationship between psychological needs, self-determined motivation, exercise attitudes, and physical fitness. *Journal of Applied Social Psychology*, 33(11), 2373-2392.

Wilson, P. M., Rodgers, W. M., & Fraser, S. N. (2002). Examining the psychometric properties of the Behavioral Regulation for Exercise Questionnaire. *Measurement in Physical education and Exercise Science*, 6(1), 1-21.

Appendices

SCIENTIFIC CAREER ANN-SOPHIE VAN HOECKE

22.09.2003 - 09.07.2005	Candidate's degree in Kinesiology Graduated magna cum laude
27.09.2005 - 07.07.2007	Master's degree in Kinesiology Field of study Physical Activity, Fitness and Health Graduated summa cum laude
01.04.2009 - 30.09.2009	Research assistant KU Leuven Faculty of Kinesiology & Rehabilitation Sciences Department of Human Kinesiology Research Centre for Exercise & Sport Psychology, and Coaching
01.10.2009 - 30.09.2013	Ph.D. student Fellowship at Research Foundation - Flanders (FWO) KU Leuven Faculty of Kinesiology & Rehabilitation Sciences Department of Kinesiology Physical Activity, Sports & Health Research Group

LIST OF PUBLICATIONS

Papers in international peer-reviewed journals

Seghers, J., **Van Hoecke**, **A. S.**, Schotte, A., Opdenacker, J., & Boen, F. (in press). The added value of a brief self-efficacy coaching on the effectiveness of a 12-week physical activity program. *Journal of Physical Activity and Health*.

Van Hoecke, **A. S.**, Delecluse, C., Bogaerts, A., & Boen, F. (in press). The long-term effectiveness of need-supportive physical activity counseling compared with a standard referral in sedentary older adults. *Journal of Aging and Physical Activity*.

Van Hoecke, **A. S.**, Delecluse, C., Bogaerts, A., & Boen, F. (in press). Effects of need-supportive physical activity counseling on well-being: A two-year follow-up among sedentary older adults. *Journal of Physical Activity and Health*.

Van Hoecke, **A. S.**, Delecluse, F., Opdenacker, J., Lipkens, L., Martien, S., & Boen, F. (2012). Long-term effectiveness and mediators of a need-supportive physical activity coaching among Flemish sedentary employees. *Health Promotion International*. doi:10.1093/heapro/das025

Van Hoecke, **A. S.**, Delecluse, C., Opdenacker, J., & Boen, F. (2013). Year-round effectiveness of physical activity counseling on subjective well-being: A self-determination approach among Flemish sedentary adults. *Applied Research in Quality of Life*. doi:10.1007/s11482-013-9251-9

Van Hoecke, **A. S.**, Vanbeselaere, N., & Boen, F. (submitted). The long reach of identity-based physical activity promotion: A comparative effectiveness study among sedentary older adults.

Meeting abstracts, presented at international conferences

Boen, F., **Van Hoecke**, **A. S.**, Bogaerts, A., & Delecluse, C. Need-supportive physical activity counseling in older adults: The mediating role of autonomous motivation in long-term behavior change. National Strategic Summit: Roadmap for Physical Activity, Lifestyle, and Comparative Effectiveness Research. Phoenix, 17 November 2012.

Seghers, J., **Van Hoecke**, **A. S.**, Schotte, A., & Boen, F. The effectiveness of elaborating physical activity intentions in a 12-week physical activity programme: A randomized trial. 4th Conference and 9th Annual Meeting of the European Network for the Promotion of Health-Enhancing Physical Activity. Helsinki, 21-24 October 2013.

Van Hoecke, **A. S.**, Bogaerts, A., Delecluse, C., Groeninck, S., Hendrickx, J., & Boen, F. Promotion of physical activity among the elderly: Does need-supportive coaching offer an added value on physical parameters? 4th International SDT Conference. Ghent, 13-16 May 2010.

Van Hoecke, **A. S.**, Bogaerts, A., Delecluse, C., Groeninck, S., Hendrickx, J., & Boen, F. Promotion of physical activity among the elderly: Does need-supportive coaching offer an added value? 11th International Conference of Sport Psychology and ENYSSP Workshop. Trikala, 4-6 November 2010.

Van Hoecke, **A. S.**, Delecluse, C., Bogaerts, A., & Boen, F. Evaluating the long-term effectiveness of three physical activity programs among older adults. 17th Annual Congress of the European College of Sport Science. Bruges, 4-7 July 2012.

Van Hoecke, **A. S.**, Delecluse, C., Opdenacker, J., Lipkens, L., Martien, S., & Boen, F. Long-term effectiveness and mediators of need-supportive physical activity coaching among Flemish sedentary employees. 13th European Congress of Sport Psychology. Madeira, 12-17 July 2011.

Van Hoecke, **A. S.**, Delecluse, C., Opdenacker, J., Lipkens, L., Martien, S., & Boen, F. Long-term effectiveness and mediators of need-supportive coaching on physical activity and well-being among sedentary employees. 3th Conference and 7th Annual Meeting of the European Network for the Promotion of Health-Enhancing Physical Activity. Amsterdam, 11-13 October 2011.

Van Hoecke, **A. S.**, Delecluse, C., Opdenacker, J., Lipkens, L., Martien, S., & Boen, F. Long-term effectiveness and mediators of need-supportive physical activity coaching among Flemish sedentary employees. 12th Annual Meeting of the International Society for Behavioral Nutrition and Physical Activity. Ghent, 22-25 May 2013.

Van Hoecke, **A. S.**, Delecluse, C., Bogaerts, A., & Boen, F. Need-supportive physical activity counseling in older adults: The mediating role of autonomous motivation in long-term behavior change. 12th Annual Meeting of the International Society for Behavioral Nutrition and Physical Activity. Ghent, 22-25 May 2013.
(winner of the Student Poster Presentation Award)

Van Hoecke, **A. S.**, Vanbeselaere, N., & Boen, F. Targeting the personal and social self: Year-round effectiveness of identity-based physical activity promotion among sedentary older adults. 12th Annual Meeting of the International Society for Behavioral Nutrition and Physical Activity. Ghent, 22-25 May 2013.

Meeting abstracts, presented at local conferences

Van Hoecke, **A. S.**, Delecluse, C., Bogaerts, A., Groeninck, S., Hendrickx, J., & Boen, F. Promotion of physical activity among the elderly: Does need-supportive coaching offer an added value to physical and psychological parameters? 14th Symposium Flemish Society for Kinesiology. Leuven, 17 December 2009.

Van Hoecke, **A. S.** Physical activity promotion among older adults: From self-determination to self-categorization. Annual Meeting Center for Social and Cultural Psychology & Physical Activity, Sports & Health Research Group. 17 May 2011.

Van Hoecke, **A. S.**, Delecluse, C., Bogaerts, A., & Boen, F. Comparing long-term effectiveness of three additional physical activity programs among older adults. 16th Symposium Flemish Society for Kinesiology. Ghent, 16 December 2011.

Van Hoecke, **A. S.**, Delecluse, C., Opdenacker, J., Lipkens, L., Martien, S., & Boen, F. Long-term effectiveness and mediators of need-supportive coaching on physical activity and well-being among sedentary employees. 3th Annual Meeting of the Belgian Nutrition Society. Brussels, 20 April 2012.

Van Hoecke, **A. S.** Targeting the personal or social self: Comparison of three identity-based physical activity counseling strategies among sedentary older adults. Annual Meeting Center for Social and Cultural Psychology & Physical Activity, Sports & Health Research Group. 27 February 2013.

APPOSITIONS - BIJSTELLINGEN

(1) Omwille van de toenemende vergrijzing is wetenschappelijk onderzoek binnen de oudere populatie bijzonder relevant. Onderzoek naar de therapeutische mogelijkheden bij ouderen wordt echter vaak als waardevoller geacht dan onderzoek naar de preventieve mogelijkheden. De aandacht voor preventieve gezondheidspromotie is, zowel vanuit individueel als maatschappelijk perspectief, even belangrijk als curatieve geneeskunde.

(2) Doordat bewegingscoaching zich op het kruispunt van verschillende onderzoeksdomeinen bevindt (o.a. psychologie, trainingsleer, gezondheidsbeleid ...), bevordert dit de interfacultaire en interdisciplinaire samenwerking binnen de universiteit alsook de persoonlijke en professionele ontwikkeling van onderzoekers, in het bijzonder van doctoraatsstudenten.

(3) De grote publicatiedruk verhindert onderzoekers vaak om hun ideeën te laten groeien en verkleint bijgevolg de mogelijkheid om een onderzoeksdesign te optimaliseren. Daardoor kunnen zowel de kwaliteit als het maatschappelijk belang van wetenschappelijk onderzoek in het gedrang komen, zeker binnen het domein van de bewegingspromotie.